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Neighbourhood Characteristics and the Distribution of Crime: Edmonton, Halifax and Thunder Bay

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Josée Savoie, Editor, Canadian Centre for Justice Statistics

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Note of appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued cooperation and goodwill.

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Introduction

The studies presented in this report are part of a series of spatial analyses of crime data conducted by Statistics Canada using Geographic Information System technology in Canadian cities. These studies, which were funded by the National Crime Prevention Centre at Public Safety Canada, examine the relationships between the distribution of crime and characteristics of demographic, socio-economic and land-use situations within cities. This report describes and explains the spatial models of crime in the cities of Edmonton, Halifax and Thunder Bay.

Spatial analyses of crime data provide a visual representation of areas of concentrated crime and help identify neighbourhood characteristics related to variations in crime levels. It can be an important tool for the development and implementation of crime reduction strategies.

The various mapping studies undertaken by the Canadian Centre for Justice Statistics support the ecology of crime, especially as regards social disorganization and opportunities for crime. In the Canadian context, studies on neighbourhood characteristics and the distribution of crime (Fitzgerald 2004; Savoie 2006; Wallace 2006; Kitchen 2006; Andresen 2007) also showed that crime is not distributed equally in cities; rather, it is often concentrated in particular neighbourhoods.

The study on neighbourhood characteristics and the distribution of crime in Winnipeg (Fitzgerald 2004) showed that in 2001, crime was concentrated in the city centre, which occupies a relatively small proportion of Winnipeg's geographic area. A similar pattern is observed in Regina, where, in 2001, the majority of violent crimes and property crimes were concentrated in the city centre, with small hot spots of property crime scattered throughout the city, generally close to shopping malls (Wallace 2006). On the Island of Montréal in 2001, property crimes were strongly concentrated in the city centre, but violent crimes were distributed among various neighbourhoods on the island (Savoie 2006). Collectively, these studies support the notion that urban crime is not distributed equally or randomly. It is, instead, often concentrated in particular areas and associated with other factors related to the population and land use characteristics.

These studies demonstrate major differences between the characteristics of high- and lower-crime neighbourhoods. When all other factors are held constant, the level of socio-economic disadvantage of people in a neighbourhood is the factor most strongly associated with the higher rates of violent and property crime in Winnipeg. In Montréal, three factors are associated with high crime rates in neighbourhoods: low income, the proportion of single people and commercial land use. In Regina, the factors associated with high crime rates in neighbourhoods are residents' low income and education levels and larger proportions of young men aged 15 to 24.

The following questions are raised in these studies: How are police-reported criminal incidents distributed among the cities' neighbourhoods? Is the crime rate in a neighbourhood associated with specific factors, such as its demographic, socio-economic, housing and land use characteristics? Is the crime rate in a neighbourhood affected by nearby neighbourhoods? These questions are explored using data from the 2001 Census of Population, the 2001 and 2003 Incident-based Crime Reporting Survey (UCR2), and land use data provided by the cities of Thunder Bay and Halifax.

These studies draw on data reported by the police, which provide a particular perspective on the nature and extent of crime. In other words, they cover only crimes known to the police. Many factors can influence police-reported crime rates, including the public's willingness to report crimes to the police and changes in legislation, policies or enforcement practices.

According to the 2004 General Social Survey (GSS) on victimization, 34% of victimization incidents at the national level were reported to the police in 2004. Specifically, police services were informed of 31% of all personal victimizations and 37% of all household crimes. Overall, breaking and entering incidents were more likely to be reported (54%) and sexual assaults, less likely (8%). Whereas population surveys such as the GSS are designed to collect information from respondents on incidents in which they were subject to criminal victimization, whether or not they were reported to the police, these data are not currently available at the neighbourhood level in Canada.

Statistics Canada conducts the Census of Population every five years, most recently in 2006. This study drew on 2001 police data and census data for the same year so the data would be most compatible. When the studies on Edmonton, Halifax and Thunder Bay were carried out, however, detailed data on population characteristics relating to individual income from the 2006 Census were not yet available at the neighbourhood level.

Structure of report

This report has four parts. The first part of the report presents the results of analyses of each of the cities studied. This section therefore includes three subsections: Edmonton, Halifax and Thunder Bay. The second part discusses the major findings and some of the limitations and future opportunities in spatial analysis of crime. The third section describes the methods used: mapping and geocoding, description of variables, and statistical methods. Lastly, the appendix feature different maps and tables.

Supplementing the analytical findings of this research paper, three additional publications are available,

1. Appendix 1: Neighbourhood characteristics and the distribution of crime in Edmonton,
2. Appendix 2: Neighbourhood characteristics and the distribution of crime in Halifax, and
3. Appendix 3: Neighbourhood characteristics and the distribution of crime in Thunder Bay.

These present neighbourhood profiles and the mapping of different incidents for the cities of Edmonton, Halifax and Thunder Bay.

Abstract

This research paper explores the spatial distribution of crime in the cities of Edmonton, Halifax and Thunder Bay and various social, economic and functional neighbourhood characteristics of these cities. The analyses are based on data from the 2001 Census, police-reported crime data from the Incident-based Uniform Crime Reporting Survey and land use data.

The research findings on Edmonton, Halifax and Thunder Bay show that crime is not distributed randomly in urban areas but is somewhat concentrated in certain neighbourhoods. These findings also highlight differences between the characteristics of high- and lower-crime neighbourhoods. These differences can be grouped under three major dimensions: demographic, socio-economic and functional.

When all other factors in this study are held constant, a limited number are found to be linked to variations in the crime rate at the neighbourhood level. The three major dimensions are represented as factors in the explanatory models, and they illustrate the regional distinctiveness of each city. Thus, the set of explanatory factors varies in a specific way according to the city that is being studied and to the type of crime—violent or property.

In Edmonton in 2001, when all neighbourhood characteristics available in the framework of the study are held constant, three characteristics contribute to the explanation of variations in the violent and property crime rate: the proportions of lone-parent families, people with no high school diploma and the number of workers in retail trade (as an indicator of commercial land used). The rates of violent and property crime, then, are higher in neighbourhoods where there is a greater proportion of people with these characteristics. The rate of violent crime is also higher in neighbourhoods where there is a higher proportion of people in a low-income situation. However, the rate of property crime is lower where there is a larger proportion of children less than 15 years of age, which tends to occur, in residential neighbourhoods with a higher proportion of owner–occupants and single-family homes.

In Halifax, when all other study characteristics are taken into account, results indicate that several characteristics linked to variation in neighbourhood crime rates are different in areas north-east of Halifax Harbour than in areas south-west of the harbour. In fact, violent crime rates north-east of the harbour are higher in neighbourhoods with larger proportions of commercial zoning and populations with lower levels of education. In the area south-west of the harbour, violent crime rates are higher in neighbourhoods where more people live alone, and the housing situation is poor, as indicated by the proportion of houses in need of major repairs. However, violent crime rates on either side of the harbour are higher in neighbourhoods with more single-mother families. These families tend to be living in low-income situations.

Property crime rates in the north-east area of Halifax Harbour are higher in neighbourhoods with more commercial zoning and higher rates of unemployment. On the south-west side of the harbour, a neighbourhood's property crime rate increases with higher proportions of people spending more than 30% of their income on housing, as well as higher median household incomes.

In Thunder Bay, when all the other study characteristics are taken into account, violent crime rates are higher in neighbourhoods with higher proportions of people who are single, have limited access to economic resources, are living in low-income households and where the percentage of revenue from government transfer payments made up the greatest proportion of their revenue. Property crimes are higher in neighbourhoods with higher proportions of people whose percentage of revenue from government transfers was higher, who are single, and who are living in buildings built before 1961.

These results suggest that strategies to combat crime could be based on the region's demographic, socio-economic and land-use situations. When developed according to the needs of a given city—i.e., its history and the opportunities available to communities in various neighbourhoods—the strategies will be more likely to achieve their objectives.

Neighbourhood characteristics and the distribution of crime in Edmonton

By Mathieu Charron, Frédéric Bédard and Cory Aston, Statistics Canada

Edmonton in context

In 2001, the Edmonton census metropolitan area (CMA) had a population of 938,845. It was the sixth most populous CMA in Canada, home to approximately one-third of Alberta's population. From 2001 to 2006, as from 1996 to 2001, Edmonton registered the fourth largest population growth of all Canadian CMAs. In 2006, Edmonton was the most northerly urban area with a population of more than 1 million (1,034,945) in North America. This robust growth is associated with the favourable economic situation in Alberta, which is mainly due to the strength of the oil industry.

The City of Edmonton, which is the focus of this study, lies at the centre of the CMA and covers 684 square kilometres. In 2001, the city had a population of 666,104. The geographic area of the City of Edmonton is entirely served by the Edmonton Police Service, which in 2001 was made up of 1,194 officers distributed among 4 divisions and 12 community police stations (Filyer 2002).

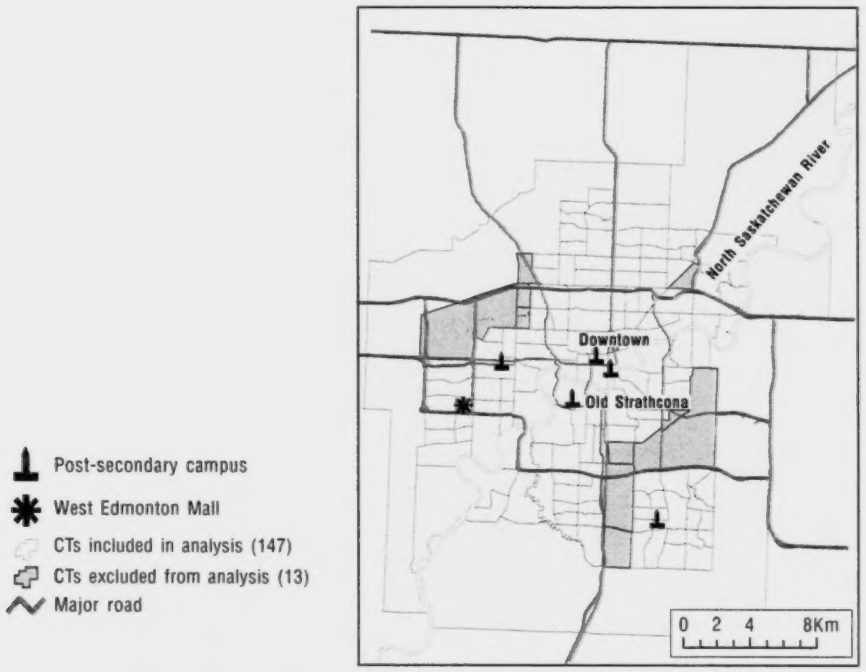
The City of Edmonton is situated on relatively flat farmland that is among the most fertile on the Prairies. The North Saskatchewan River separates the north and south parts of the city. Some neighbourhoods of the city have undergone revitalization, including the city centre and the Old Strathcona district. The City of Edmonton also has a number of commercial areas, including the West Edmonton Mall, one of the largest shopping malls in the world (Map 1.1).

In the 2004 General Social Survey, residents of the Edmonton CMA reported a rate of violent victimization in Canada of 191 violent victimization incidents per 1,000 inhabitants aged 15 and over, and a household victimization rate of 361 household victimization incidents per 1,000 households (Gannon and Mihorean 2005). However, residents of the Edmonton CMA are no exception to the general trend observed in Canada: residents of the Prairie CMAs (Winnipeg, Regina, Saskatoon and Calgary) reported rates of violent victimization and household victimization above the Canadian average (111 violent victimization incidents per 1,000 inhabitants aged 15 and over and 248 household victimization incidents per 1,000 households).

Chart 1.1 illustrates the general trends in crime rates over the past 15 years as reported by various police services in Canada. In the early 1990s, Edmonton's crime rate fell. From 1994 to 2001, it remained below the level of 10,000 Criminal Code offences per 100,000 inhabitants. The crime rate then increased, peaking in 2004 (11,332 per 100,000 inhabitants). Throughout the study period, crime rates in

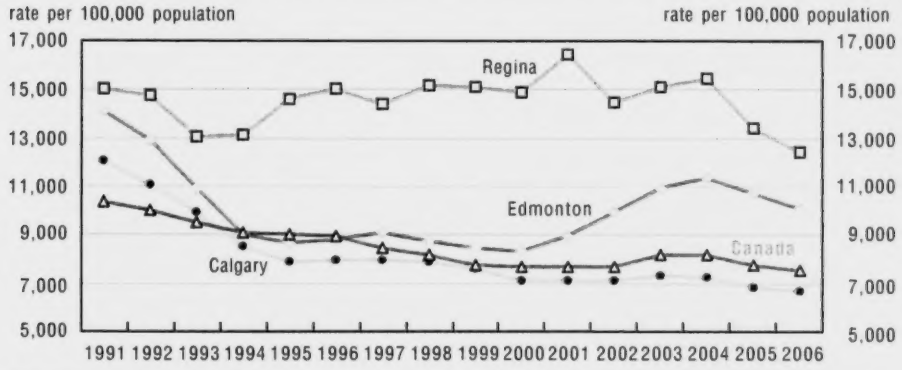
Edmonton were greater than those registered by Calgary and, with a few exceptions, those at the national level. By contrast, they remained lower than those registered in Regina.

Map 1.1
Local context and census tracts (CTs), Edmonton, 2001



Source: Statistics Canada, Census, 2001.

Chart 1.1
Crime rates[1] in selected census metropolitan areas, Canada, 1991 to 2006



1. Rates based on count of total *Criminal Code* incidents excluding traffic offences.

Source: Statistics Canada, Canadian Centre for Justice Statistics, Uniform Crime Reporting Survey, 1991 to 2006.

The offence categories included in this study are violent crimes, property crimes, drug offences, prostitution, offensive weapons, and gaming and betting offences. In 2001, the Edmonton Police Service reported more than 58,000 of these offences, the vast majority of which were property crimes (83%), followed by violent offences (13%) and other offences (5%), which include prostitution and crimes related to drugs, offensive weapons and gaming and betting. These crime rates are fairly similar to those at the national level, namely 79%, 17% and 4%, respectively.

Distribution of crime in the City of Edmonton in 2001

In 2001, the Edmonton Police Service reported criminal incidents in 160 neighbourhoods or census tracts (CTs) (Table 1.1 and Table 1.2). However, these incidents were not evenly dispersed throughout the study area but were instead concentrated in particular neighbourhoods of the municipality. Just 10 CTs accounted for 32% of violent crimes and 23% of property crimes reported by the police service.

Table 1.1

Count of police-reported crime incidents, census tracts (CTs), Edmonton, 2001

Offences	Count of incidents[1]			
	Total all CTs	CT average	CT minimum	CT maximum
	number			
Total incidents[2]	54,697	342	0	2,036
Total violent incidents[2]	7,145	45	0	472
Total property incidents[2]	44,799	280	0	1,572
Drug incidents[2]	950	6	0	93
Other[2,3]	1,803	11	0	392
Selected offences				
Arson[4]	338	2	0	20
Assault level 1[4]	3,056	19	0	171
Assault levels 2 and 3[4]	1,432	9	0	104
Break and enter[4]	7,021	44	0	182
Motor vehicle theft[4]	6,336	40	0	244
Drug incidents[4]	1,654	10	0	147
Homicide[4,5]	31	0	0	5
Mischief[4]	8,575	54	0	256
Prostitution[4]	863	5	0	377
Robbery[4]	1,262	8	0	123
All sexual offences[4,6]	570	4	0	28
Shoplifting[4]	3,907	24	0	389
Theft under $5,000 (without motor vehicle theft)[4]	19,451	122	0	911
Theft over $5,000 (without motor vehicle theft)[4]	568	4	0	25

1. Total count based on 160 CTs.
2. Includes most serious violation in each incident only.
3. Includes prostitution, offensive weapons, gaming and betting and other residual *Criminal Code* offences.
4. Includes all recorded violations in each incident.
5. Includes attempted murder and conspire to commit murder.
6. Includes sexual assault (levels 1 to 3) and other sexual violations.

Source: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001.

Table 1.2

Rates of police-reported crime incidents, census tracts (CTs), Edmonton, 2001

Offences	Rate of incidents per 1,000 residential and employed population[1]		
	CT average	CT minimum	CT maximum
		rate	
Total incidents[2]	55	4	220
Total violent incidents[2]	7	0	38
Total property incidents[2]	45	3	159
Drug incidents[2]	1	0	7
Other[2,3]	2	0	93
Selected offences			
Arson[4]	0	0	4
Assault level 1[4]	3	0	13
Assault levels 2 and 3[4]	1	0	7
Break and enter[4]	7	0	23
Motor vehicle theft[4]	7	0	24
Drug incidents[4]	2	0	12
Homicide[4,5]	0	0	1
Mischief[4]	9	0	27
Prostitution[4]	1	0	89
Robbery[4]	1	0	11
All sexual offences[4,6]	1	0	4
Shoplifting[4]	3	0	35
Theft under $5,000 (without motor vehicle theft)[4]	19	0	71
Theft over $5,000 (without motor vehicle theft)[4]	0	0	2

1. Rate based on the 147 CTs where the total residential population was over 250 people.
2. Includes most serious violation in each incident only.
3. Includes prostitution, offensive weapons, gaming and betting and other residual *Criminal Code* offences.
4. Includes all recorded violations in each incident.
5. Includes attempted murder and conspire to commit murder.
6. Includes sexual assault (levels 1 to 3) and other sexual violations.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

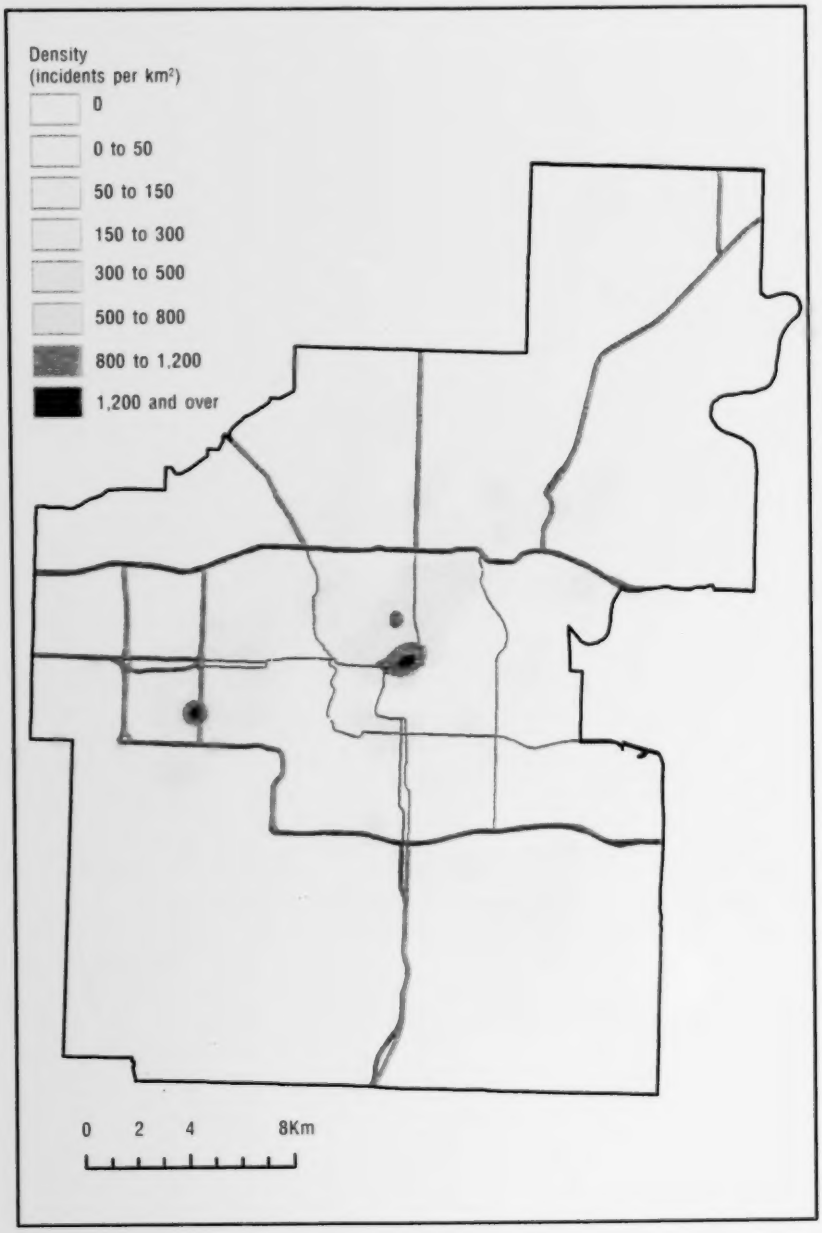
Map 1.2 and Map 1.3 show the density of crime incidents in Edmonton in 2001. Violent crime and property crime incidents exhibit similar spatial distributions. The city centre and the West Edmonton Mall area show the highest concentrations. The neighbourhoods south of the river exhibit only one higher concentration, around Whyte Avenue in the Old Strathcona district.

Most of the property crime hot spots in the City of Edmonton correspond to the municipality's different areas of commercial activity (Map 1.2). The highest concentrations are around the city centre and the West Edmonton Mall. These concentrations account for a sizable portion of incidents of theft under $5,000, shoplifting and vehicle theft. Other neighbourhoods have lower concentrations of property crime, including Old Strathcona and particular shopping malls. Violent crime incidents are concentrated near the city centre. The neighbourhoods bordering on the West Edmonton Mall, Whyte Avenue and the areas around the different campuses of Grant MacEwan College are medium-intensity hot spots (Map 1.3).

Thus, some crime hot spots in Edmonton neighbourhoods exhibit a concentration of several types of crimes. This is the case in particular with the city centre and Whyte Avenue, respectively to the north and south of the North Saskatchewan River, which account for a sizeable proportion of incidents of assault, breaking and entering, drugs, mischief and sex crimes.[1]

Map 1.2

Kernel density distribution of property crime incidents, Edmonton, 2001

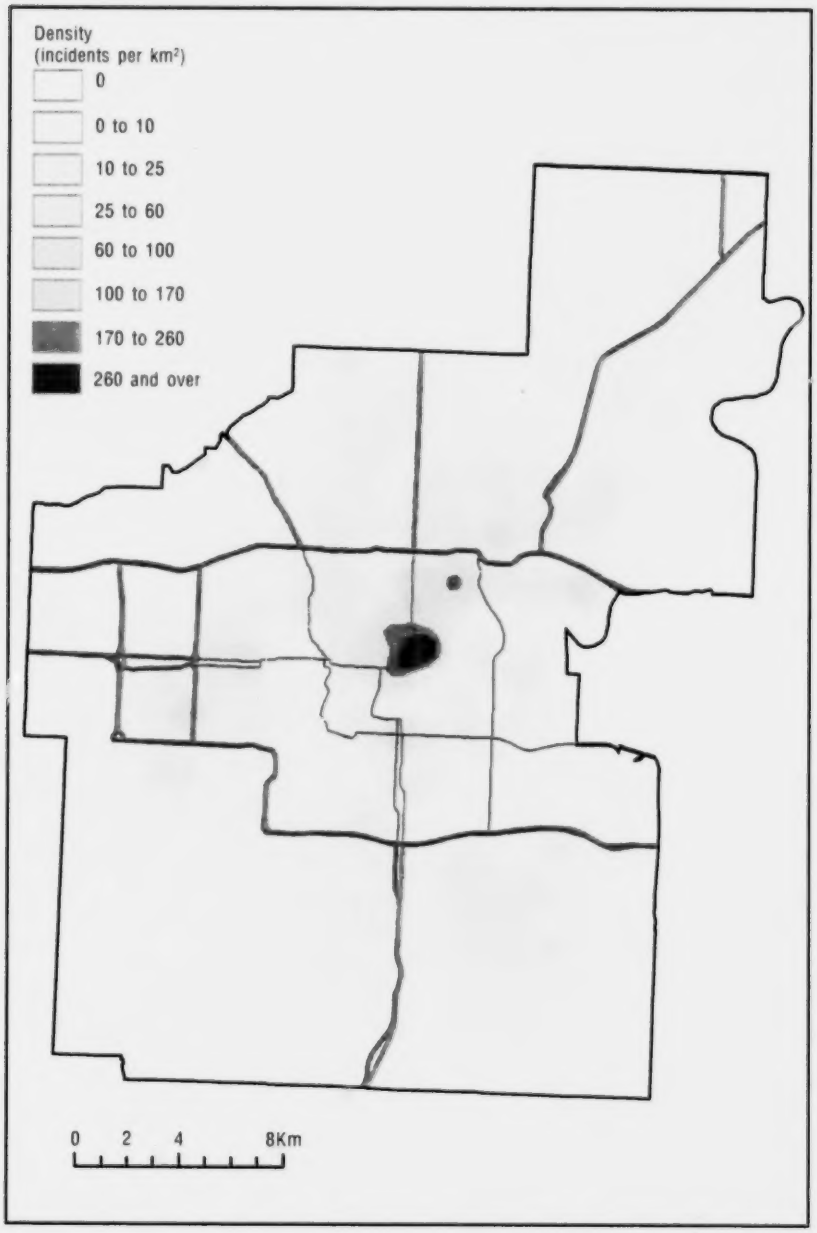


Based on 44,799 property crime incidents.

Source: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001.

Map 1.3

Kernel density distribution of violent crime incidents, Edmonton, 2001



Based on 7,145 violent crime incidents.

Source: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001.

The spatial organization of crime in 2003 is largely the same as in 2001. Concentrations of violent crime are almost identical and growth in property crime is distributed among the same hot spots. The coefficients of correlation between the 2001 data aggregated to the CT scale and the 2003 data demonstrate this similarity, with a correlation coefficient of 98% ($p<0.001$) for both categories of criminal incidents. The geocoded crime data for 2001 thus appear to exhibit a reliable overall pattern in the spatial organization of crime in the City of Edmonton (Map 1.4 and Map 1.5).

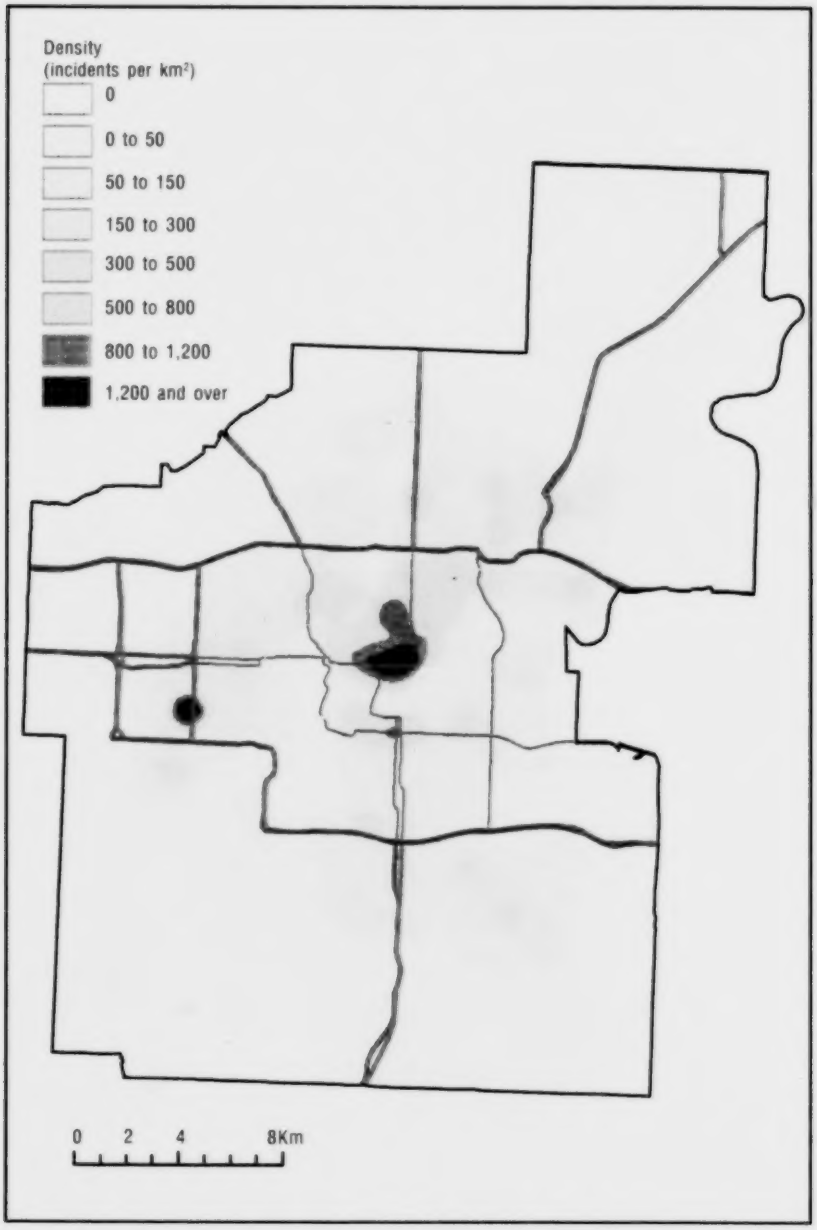
Just as in the other Canadian cities where crime mapping studies have been conducted (Fitzgerald 2004; Savoie 2006 and Wallace 2006), the busiest areas in Edmonton have the highest concentrations of crime. When the population at risk (the sum of the resident population and the worker population[2]) is taken into account in the distribution of crime, the high concentration in the city centre diminishes and several smaller, moderate-to-high concentrations appear in different neighbourhoods of the city (Map 1.6 and Map 1.7).

Shown in greater detail on Map 1.6, several property crime hot spots are seen on the periphery of the city centre. These hot spots are associated with commercial activity. In most cases, these are shopping malls, commercial streets and megastores. In this regard, the West Edmonton Mall area is a major hot spot. When neighbourhoods' population at risk is taken into account, it emerges that neighbourhoods located south of the river have the highest concentrations.

Violent crime by population at risk is dispersed among several hot spots (Map 1.7). The violent crime hot spots on the edge of the municipality tend to be associated with institutional spaces, such as schools, hospitals and the vicinity of the prison.

Map 1.4

Kernel density distribution of property crime incidents, Edmonton, 2003

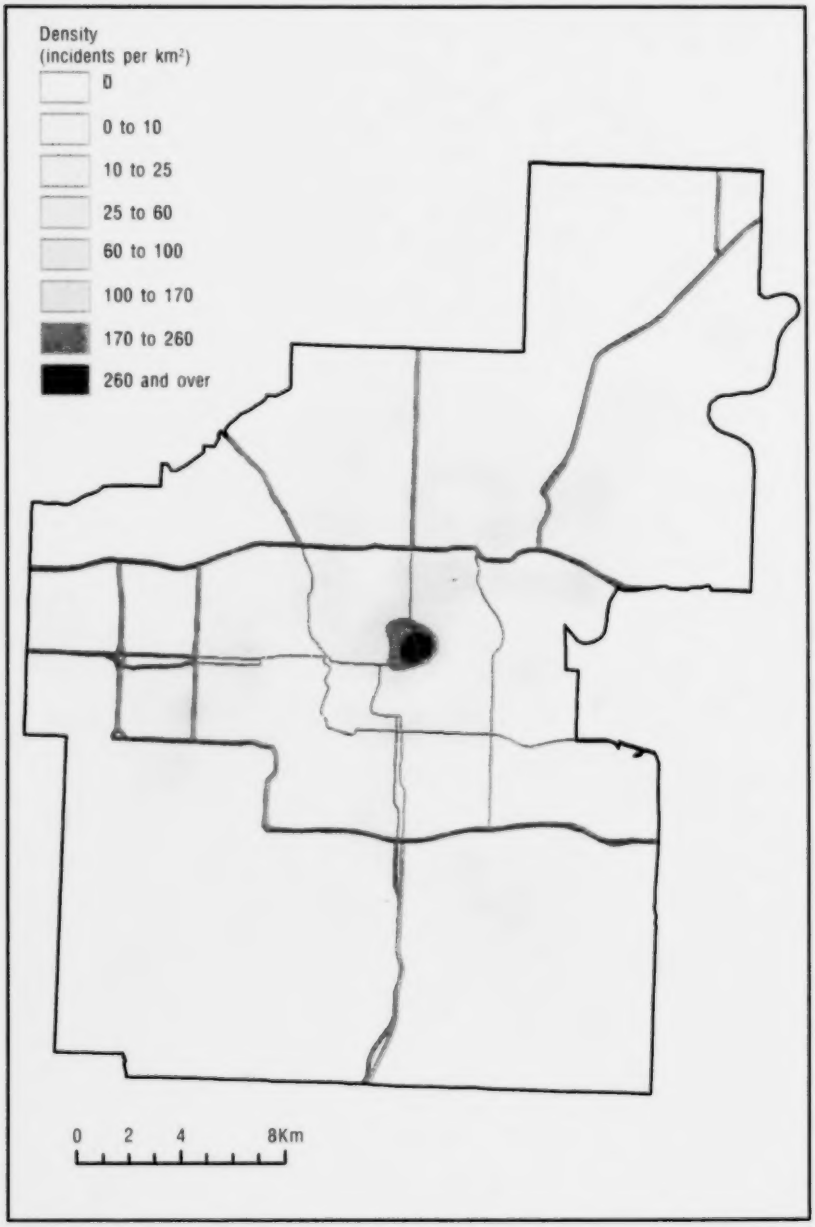


Based on 55,742 property crime incidents.

Source: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2003.

Map 1.5

Kernel density distribution of violent crime incidents, Edmonton, 2003

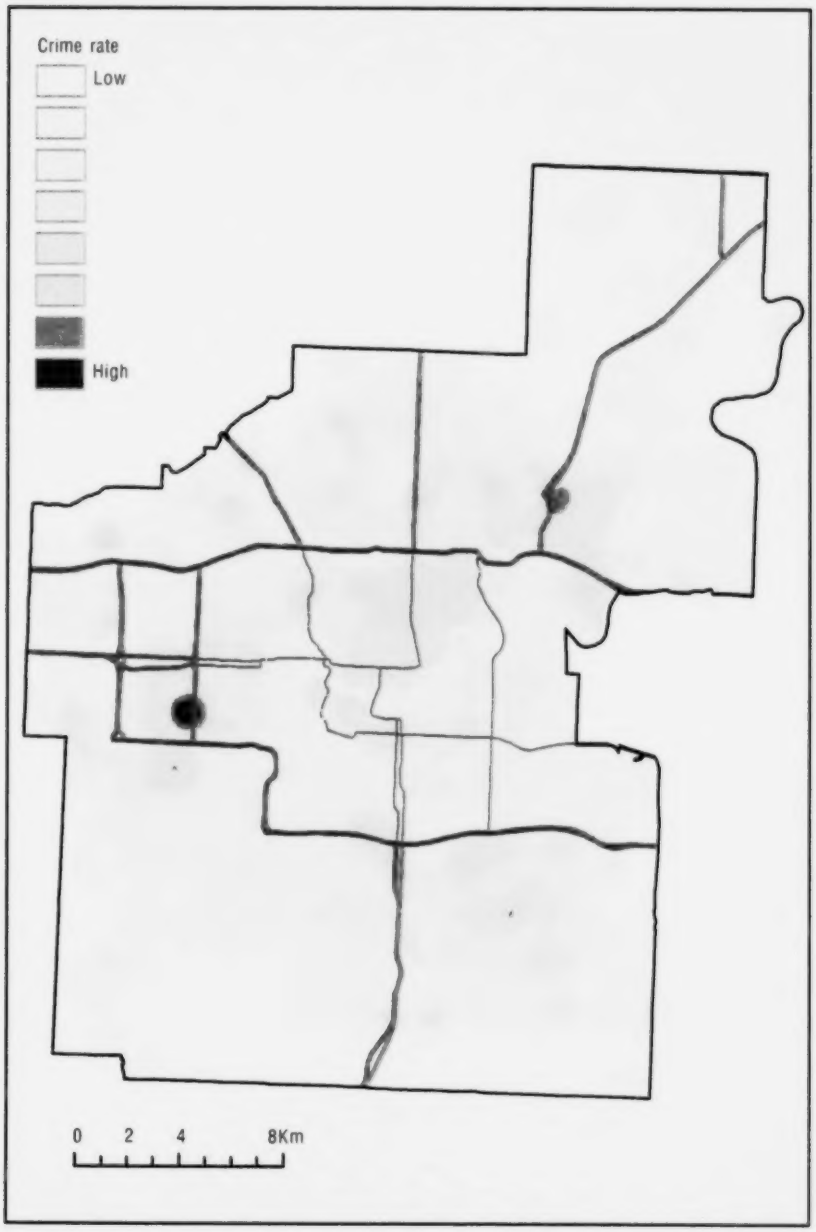


Based on 6,679 violent crime incidents.

Source: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2003.

Map 1.6

Kernel density distribution of property crime incidents and population at risk, Edmonton, 2001



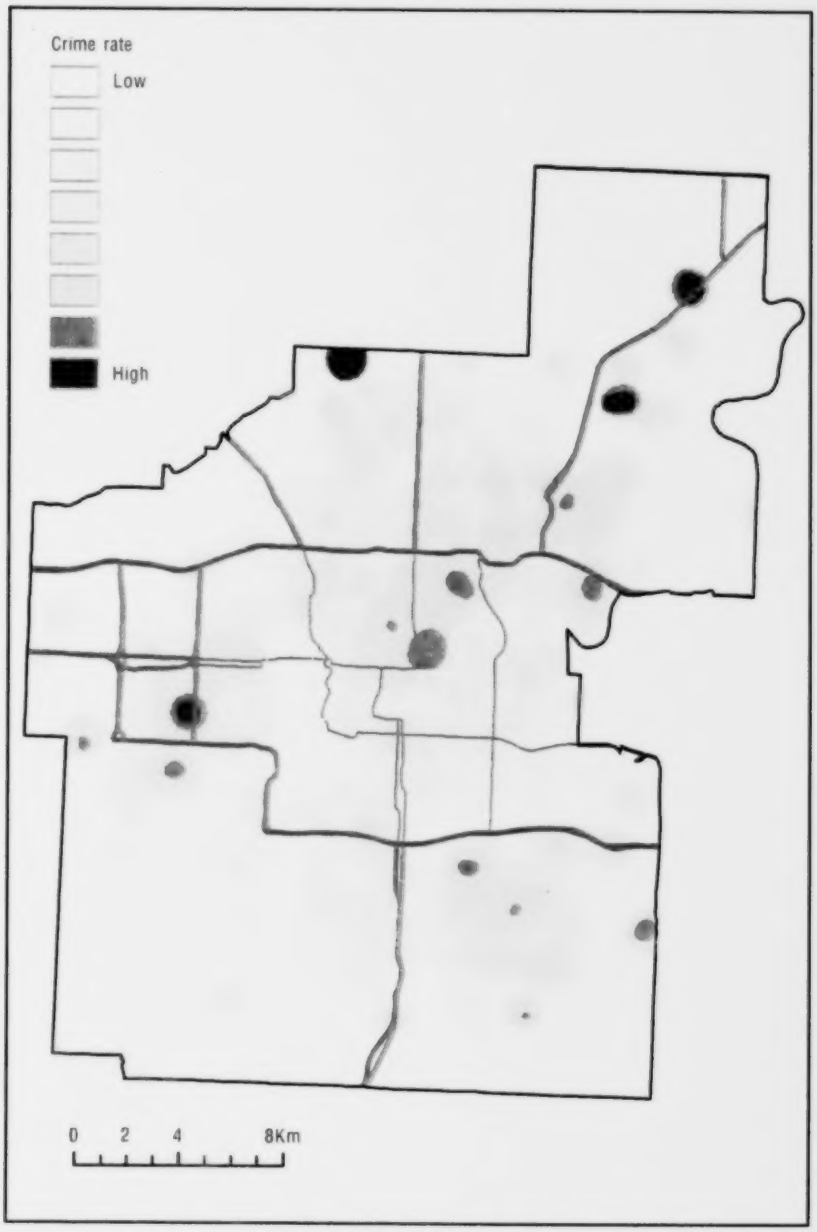
Based on 44,799 property crime incidents.

Note: Local crime rates have been adjusted to ensure data confidentiality and to avoid introducing artificial hotspots where population at risk and crime densities are low.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Map 1.7

Kernel density distribution of violent crime incidents and population at risk, Edmonton, 2001



Based on 7,145 violent crime incidents.

Note: Local crime rates have been adjusted to ensure data confidentiality and to avoid introducing artificial hotspots where population at risk and crime densities are low.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Neighbourhood characteristics and crime

This section explores the relationship between a number of neighbourhood[3] characteristics and the rates of violent crime and property crime, based on 1,000 residents and workers (population at risk) in Edmonton's CTs in 2001. To maximize the number of incidents covered, the analysis looks at overall violent and property crime rates rather than rates for individual offence types.

The analyses below use crime rates in individual neighbourhoods or CTs as reported by the Edmonton Police Service, and not the delinquency rates of the actual residents of these neighbourhoods. It is therefore important to avoid generalization errors. It should not be concluded from the results of this study that some neighbourhood characteristics are the cause of crime; rather, the results show that these factors are associated with or co-occur with higher crime rates in neighbourhoods.

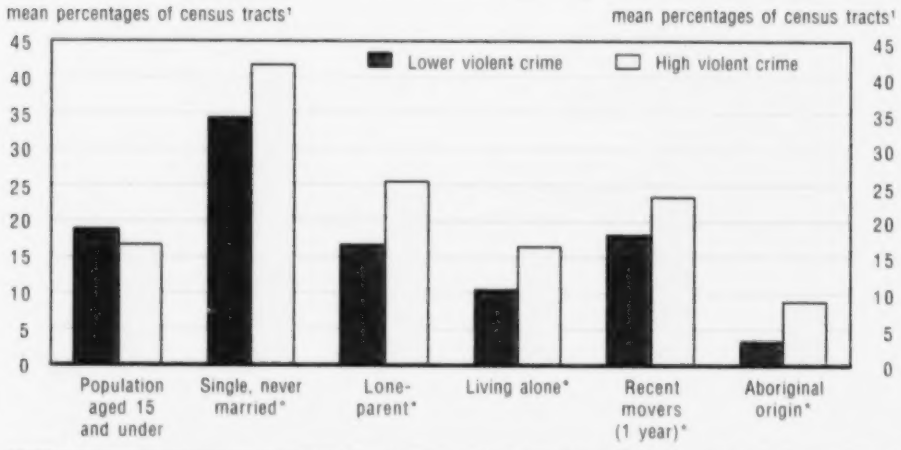
Descriptive results: a comparison of high- and lower-crime neighbourhoods

To examine the relationship between violent and property crime rates and selected neighbourhood characteristics, the 147 CTs have been divided into two groups for each crime type. The first group contains the 36 CTs (25% of the total) that recorded the highest property and violent crime rates, and the second group contains the remaining 111 (75%). The composition of the quartile consisting of high violent crime neighbourhoods is similar to that of property crime neighbourhoods. In fact, 27 CTs are in both quartiles of high-crime neighbourhoods. As a result of overlap between the two high-crime quartiles, they exhibit similar characteristics. In the interest of readability, in the next few paragraphs the analytical results are presented in detail for neighbourhoods with high violent crime but are presented only in abbreviated form for neighbourhoods with high property crime. The differences are significant at $p<0.001$ unless otherwise indicated, based on an independent samples T-test.

Before other factors are taken into account, significant differences are noted for various demographic, socio-economic, housing and land-use characteristics when neighbourhoods with high crime rates are compared with neighbourhoods with lower rates. High violent crime neighbourhoods are characterized by higher proportions of single residents (42% compared to 34% in lower-crime neighbourhoods) and lone-parent families (25% compared to 17%) (Chart 1.2 and Chart 1.3). These neighbourhoods also have higher proportions of people who identified with an Aboriginal group (9% compared to 3%), people who moved in the year preceding the census (23% compared to 18%) and people living alone (17% compared to 11%). These characteristics are also present in larger proportions in neighbourhoods in the high property crime quartile. Also, neighbourhoods with high rates of property crime have a lower proportion of people under 15 years of age (16% compared to 19%).

Chart 1.2

Demographic characteristics in neighbourhoods with high and lower rates of violent crime, Edmonton, 2001



* differences between high-crime and lower-crime means are statistically significant at: p<0.001.

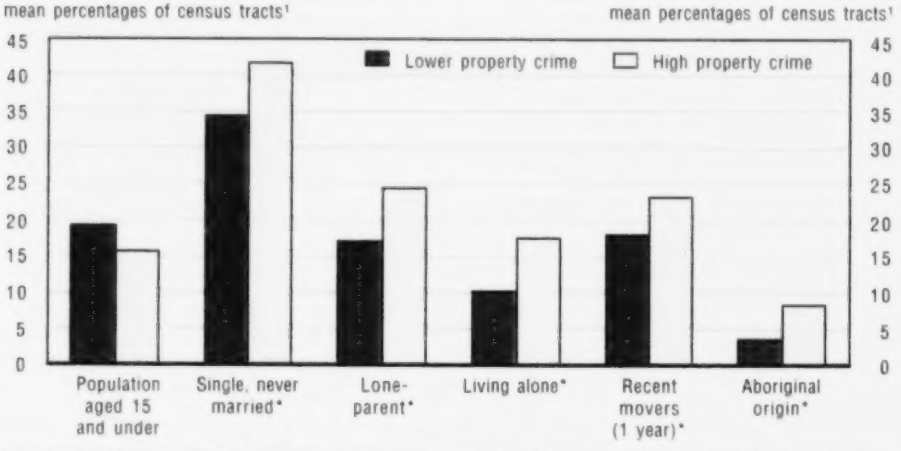
1. High-crime = census tracts falling into the highest 25% (36) of violent crime rate neighbourhoods; lower-crime = remaining 75% (111). Rate per 1,000 residential and employed population.

Note: N = 147 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Chart 1.3

Demographic characteristics in neighbourhoods with high and lower rates of property crime, Edmonton, 2001



* differences between high-crime and lower-crime means are statistically significant at: p<0.001.

1. High-crime = census tracts falling into the highest 25% (36) of property crime rate neighbourhoods; lower-crime = remaining 75% (111). Rate per 1,000 residential and employed population.

Note: N = 147 census tracts.

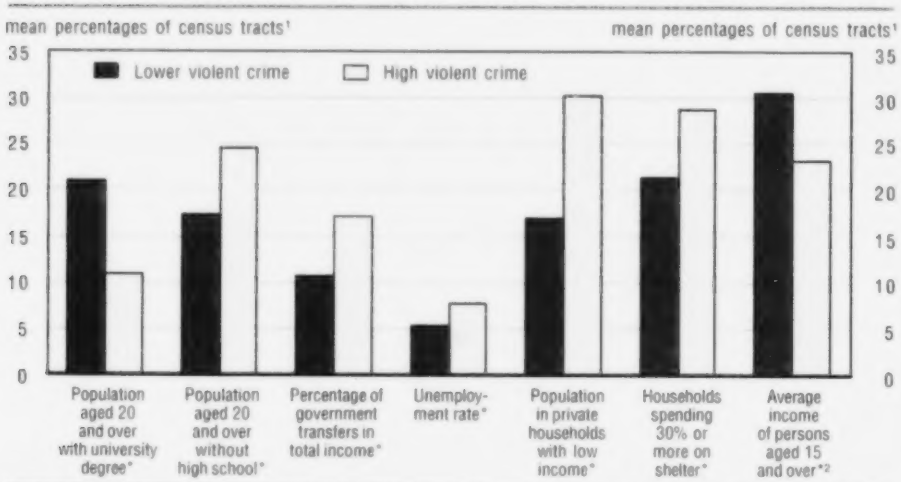
Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

High violent crime neighbourhoods register more unfavourable results on a range of socio-economic indicators than lower crime neighbourhoods (Chart 1.4 and Chart 1.5). In Edmonton, the individual incomes of residents of high-crime neighbourhoods are on average $8,000 lower than those of residents of other neighbourhoods. The unemployment rate (8% compared to 5% in lower-crime neighbourhoods) and the proportion of total income consisting of government transfers (17% compared to 11%) are also higher in these neighbourhoods. Furthermore, high-crime neighbourhoods have larger proportions of low-income households (30% compared to 17% in lower-crime neighbourhoods) and a larger proportion of households that spend more than 30% of their income on shelter (29% compared to 21%). These differences are closely related to the education level of residents. Residents of high-crime neighbourhoods are less likely to have obtained a university degree (11% and 21%) and more likely to have never finished high school (25% compared to 17%). Again, the results for high property crime neighbourhoods are almost identical.

The proportions of dwellings constructed before 1961 (38% compared to 19% in lower-crime neighbourhoods) and requiring major repairs (11% compared to 7%) are significantly higher in high-crime neighbourhoods (Chart 1.6 and Chart 1.7). Owner–occupants are less numerous (46% compared to 67%) and dwellings, on average, cost $30,000 less in high violent crime neighbourhoods. There are more apartment dwellings (44% compared to 27%) in high-crime neighbourhoods. High-crime neighbourhoods are characterized by intense commercial activity, as reflected in the ratio of residents to workers: that ratio stands at 10 residents per retail worker, whereas the corresponding ratio in other neighbourhoods is 21. The same patterns are observed for property crime.

Chart 1.4

Socio-economic characteristics in neighbourhoods with high and lower rates of violent crime, Edmonton, 2001



* differences between high-crime and lower-crime means are statistically significant at: $p<0.001$.

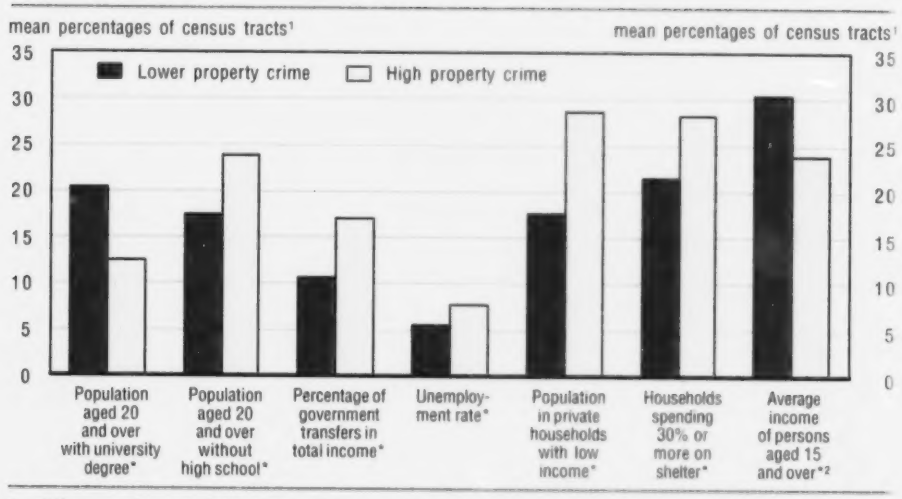
1. High-crime = census tracts falling into the highest 25% (36) of violent crime rate neighbourhoods; lower-crime = remaining 75% (111). Rate per 1,000 residential and employed population.
2. Average income of persons aged 15 and over in $1,000s.

Note: N = 147 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Chart 1.5

Socio-economic characteristics in neighbourhoods with high and lower rates of property crime, Edmonton, 2001



* differences between high-crime and lower-crime means are statistically significant at: $p<0.001$.

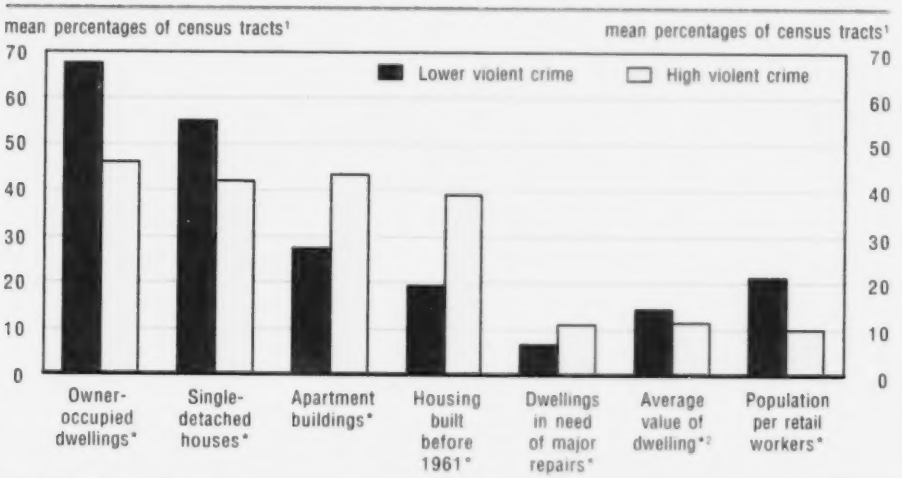
1. High-crime = census tracts falling into the highest 25% (36) of property crime rate neighbourhoods; lower-crime = remaining 75% (111). Rate per 1,000 residential and employed population.
2. Average income of persons aged 15 and over in $1,000s.

Note: N = 147 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Chart 1.6

Land-use and housing characteristics in neighbourhoods with high and lower rates of violent crime, Edmonton, 2001



* differences between high-crime and lower-crime means are statistically significant at: $p<0.001$.

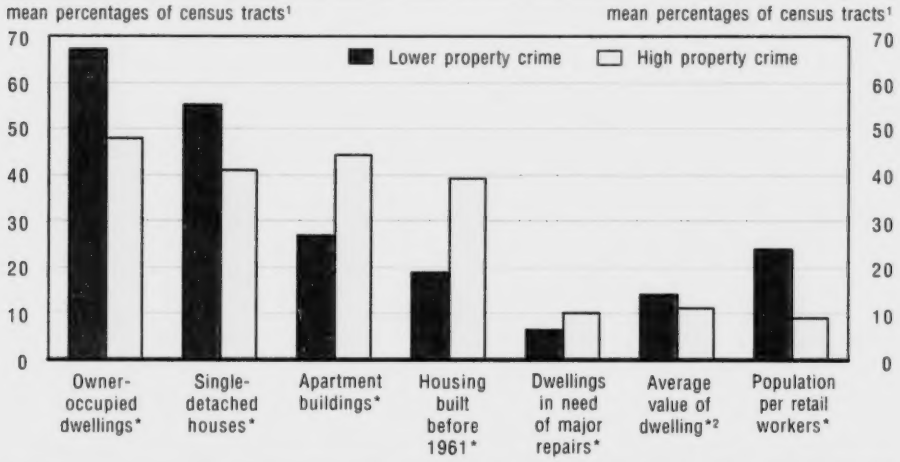
1. High-crime = census tracts falling into the highest 25% (36) of violent crime rate neighbourhoods; lower-crime = remaining 75% (111). Rate per 1,000 residential and employed population.
2. Average value of dwelling in $10,000s.

Note: N = 147 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Chart 1.7

Land-use and housing characteristics in neighbourhoods with high and lower rates of property crime, Edmonton, 2001



* differences between high-crime and lower-crime means are statistically significant at: $p<0.001$.

1. High-crime = census tracts falling into the highest 25% (36) of property crime rate neighbourhoods; lower-crime = remaining 75% (111). Rate per 1,000 residential and employed population.
2. Average value of dwelling in $10,000s.

Note: N = 147 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Results of multivariate analysis

The previous analyses have shown that certain demographic, socio-economic and land-use characteristics of neighbourhoods, when considered in isolation, are associated with higher crime rates. However, the strength of this relationship can vary when multiple characteristics are taken together. In this section, multivariate analysis is used to examine the relationship among neighbourhood characteristics and to observe how they relate to the level of crime after taking other characteristics into account. These analyses serve to determine how much the different neighbourhood characteristics overlap or, conversely, complement each other in explaining variations in crime. They also serve to evaluate whether the relationships observed between crime and some neighbourhood characteristics can be explained by other, more direct associations.[4]

To assess the relative contribution of neighbourhood characteristics to the explanation of crime, the set of variables was regressed separately on violent crime rates and property crime rates. The results are shown in Table 1.3. The modeling process reveals a set of four explanatory variables for the variation in violent crimes and another set of four variables in the case of property crimes. The spatial autoregressive model gives a squared correlation coefficient of 0.77 between the observed values for neighbourhood crime rates and the predicted values in the case of violent crimes, and of 0.71 in the case of property crimes. The estimated regression coefficients provide an indication of the relative contribution of each variable after controlling for the other variables in the model.

Table 1.3

Regression models for crime rates,[1,2] Edmonton neighborhoods, 2001

	Violent crime rate[4]	Property crime rate[4]
Square correlation coefficients	0.77	0.71
Regression coefficients (b)		
Lone-parent families[3]	0.21**	0.40***
Population without high school diploma[3]	0.25***	0.27***
Workers in retail trade[3]	0.12**	0.15**
Low income[3]	0.35***	...
Population aged 15 and under[3]	...	-0.31***
Spatial lag	0.29***	0.26***

... not applicable
* p<0.05.
** p<0.01.
*** p<0.001.

1. Crime rates per 1,000 residential and employed population.
2. Based on 147 census tracts.
3. Variables are standardized and normalized.
4. Regression models include intercept.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

The violent crime rate model shows that the proportion of neighbourhood residents living in low-income households has the greatest explanatory power. Thus, violent crime rates are higher in neighbourhoods where a larger proportion of residents live in a low-income household (b = 0.35, p<0.001). Violent crime rates are also higher where the proportions of people with no high school diploma (b = 0.25, p<0.001) and lone-parent families (b = 0.21, p<0.01) are higher. The number of workers in retail trade used as an indication of commercial zoning or activity in an area (b=0.12, p<0.01) also helps to explain the variation in violent crime levels (Table 1.3); a larger number of such workers is associated with increased levels of violent crime in neighbourhoods.

The spatial regression model applied to property crime reveals that higher rates of property crimes at the neighbourhood level are strongly associated with higher proportions of lone-parent families (b = 0.40, p<0.001) and people without a high school diploma (b = 0.27, p<0.001). Property crime incident rates are also higher in neighbourhoods with a larger proportion of workers in retail trade (b = 0.15, p<0.01). The presence of young children (population under 15 years of age) in neighbourhoods is associated with lower crime rates. The proportion of population under 15 years of age (b = -0.31, p<0.001) is a protective factor against property crime. The correlation matrix, located in the appendices, sheds light on this finding: a higher proportion of children under 15 years of age is observed in residential neighbourhoods with a higher proportion of owner–occupants and single-family homes (these two variables are linked to lower crime levels in the other Canadian cities already studied).

Summary of findings – Edmonton

Although crimes were reported in all neighbourhoods in the municipality of Edmonton in 2001, some areas have much higher concentrations. These 'hot spots' are located in the city centre and in neighbourhoods characterized by a concentration of commercial, such as shopping centres, and institutional activities, such as schools and hospitals.

Thus, the crime hot spots in Edmonton are busy places. However, when crime rates were analysed according to the population at risk, this finding was put into perspective: the strong concentration of crimes in some areas is not only attributable to the density of their population at risk. Characteristics other than density of population at risk contribute to the over-representation of crimes within certain areas.

In Edmonton in 2001, when all neighbourhood characteristics are held constant, three characteristics common to violent and property crime contribute to the explanation of variations in the crime rate level based on the population at risk: the proportion of lone-parent families, people with no high school diploma and workers in retail trade (an indicator of the use of the commercial area). Violent crime and property crime rates are then higher in neighbourhoods with a greater proportion of these characteristics. The rate of violent crime is also higher in neighbourhoods where there is a higher proportion of people in a low-income situation. However, the rate of property crime is lower where there is a larger proportion of children less than 15 years of age, which tends to occur, in residential neighbourhoods with a higher proportion of owner–occupants and single-family homes.

Endnotes

1. See Appendix 1: Neighbourhood characteristics and the distribution of crime in Edmonton.
2. Consult the Methodology section for a more detailed discussion of using the population at risk in the spatial analysis of crime.
3. The definition of the term 'neighbourhood' used in this analysis corresponds to the census tract (CT). Consult the Methodology section for more details.
4. For more information on the multivariate analysis, see the Methodology section.

Neighbourhood characteristics and the distribution of crime in Halifax

By Marnie Wallace, Frédéric Bédard and Krista Collins, Statistics Canada

Halifax in context

In 2001, the Halifax census metropolitan area (CMA), with a population of 359,183, ranked thirteenth in terms of size among the 27 CMAs in Canada.[5] The 2001 population was up 4.7% from 1996 (342,851), while the population for Nova Scotia remained virtually unchanged over the same period. In 2001, the Halifax CMA represented approximately 40% of the population of the province of Nova Scotia. By the 2006 Census, the population of the Halifax CMA had increased 3.8%, reaching 372,858 residents.

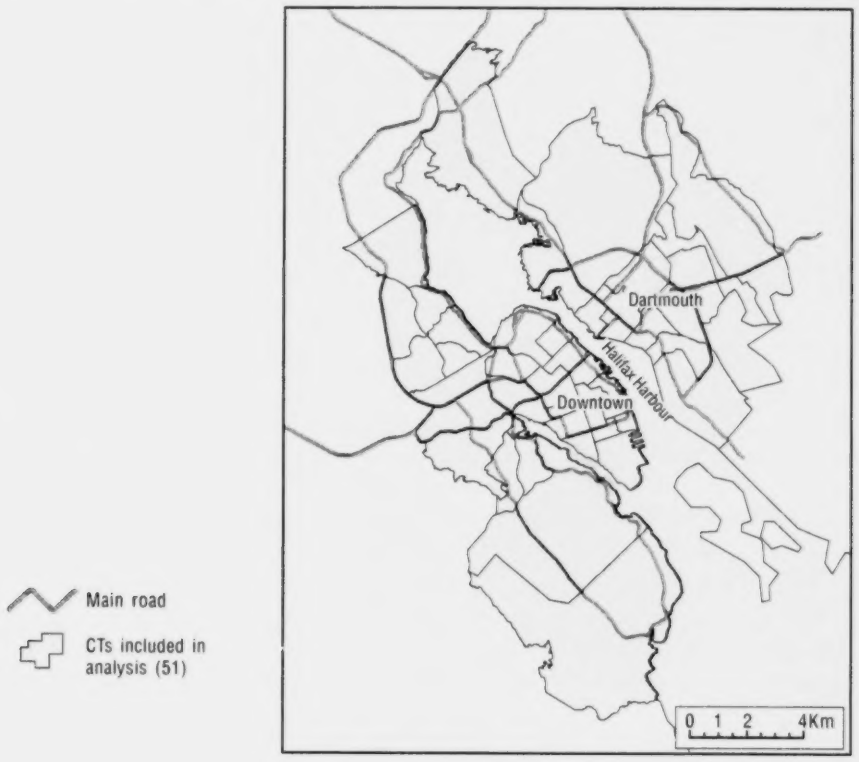
For many years, the area now known as the Halifax Regional Municipality existed as four separate municipalities. They were Halifax, on the south-west side of the harbour, Dartmouth on the north-east side of the harbour, Bedford at the top of Bedford Basin, and Halifax County, which makes up the remainder. These four areas amalgamated in 1996, to be governed by a single city council.

In 2001, the Halifax Regional Municipality was serviced by two police detachments. The Halifax Regional Police was responsible for policing the urban core of the municipality, which was divided into three divisional areas: Peninsular Halifax (Central Division), Bedford to Sambro Loop (West Division) and Dartmouth (East Division). These three areas accounted for 56% of the municipality. The remaining 44% was serviced by the Halifax County Rural RCMP detachment and was made up of the following areas: Sheet Harbour, Musquodoboit Harbour, Cole Harbour, Tantallon and Lower Sackville. This study focuses on the portion of the Halifax Regional Municipality that was policed by the Halifax Regional Police,[6] which covers approximately 160 square kilometres divided into 51 census tracts (CTs),[7] and had a population of 191,514 in 2001 (Map 2.1).[8]

Chart 2.1 compares Halifax's crime rate to other major CMAs as well as the overall rate in Canada from 1991 to 2006. The Halifax CMA follows the general trend of declining crime rates in Canada although the CMA's rate has consistently hovered above the national average throughout the 1990s and early 2000s. In fact, victimization data from the 2004 General Social Survey indicates that the total violent victimization rate reported by residents of the Halifax CMA (229 per 1,000 inhabitants aged 15 and over) was more than double the Canadian average (106 per 1,000 inhabitants aged 15 and over). However, no statistical difference was found between the rate of household crime in Halifax and the national average, 293 incidents of household crime per 1,000 households and 243 incidents of household crime per 1,000 household, respectively (Gannon and Mihorean 2005).

Map 2.1

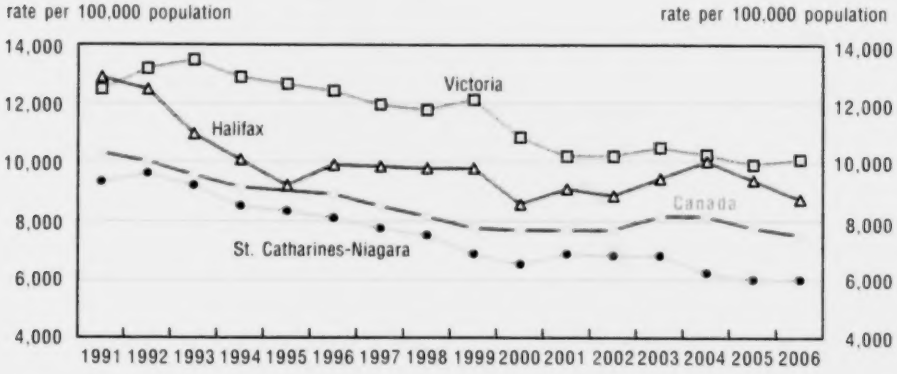
Local context and census tracts (CTs), Halifax, 2001



Source: Statistics Canada. Canadian. Census. 2001.

Chart 2.1

Crime rates[1] in selected census metropolitan areas, Canada, 1991 to 2006



1. Rates based on count of total *Criminal Code* incidents excluding traffic offences.

Source: Statistics Canada. Canadian Centre for Justice Statistics. Uniform Crime Reporting Survey, 1991 to 2006.

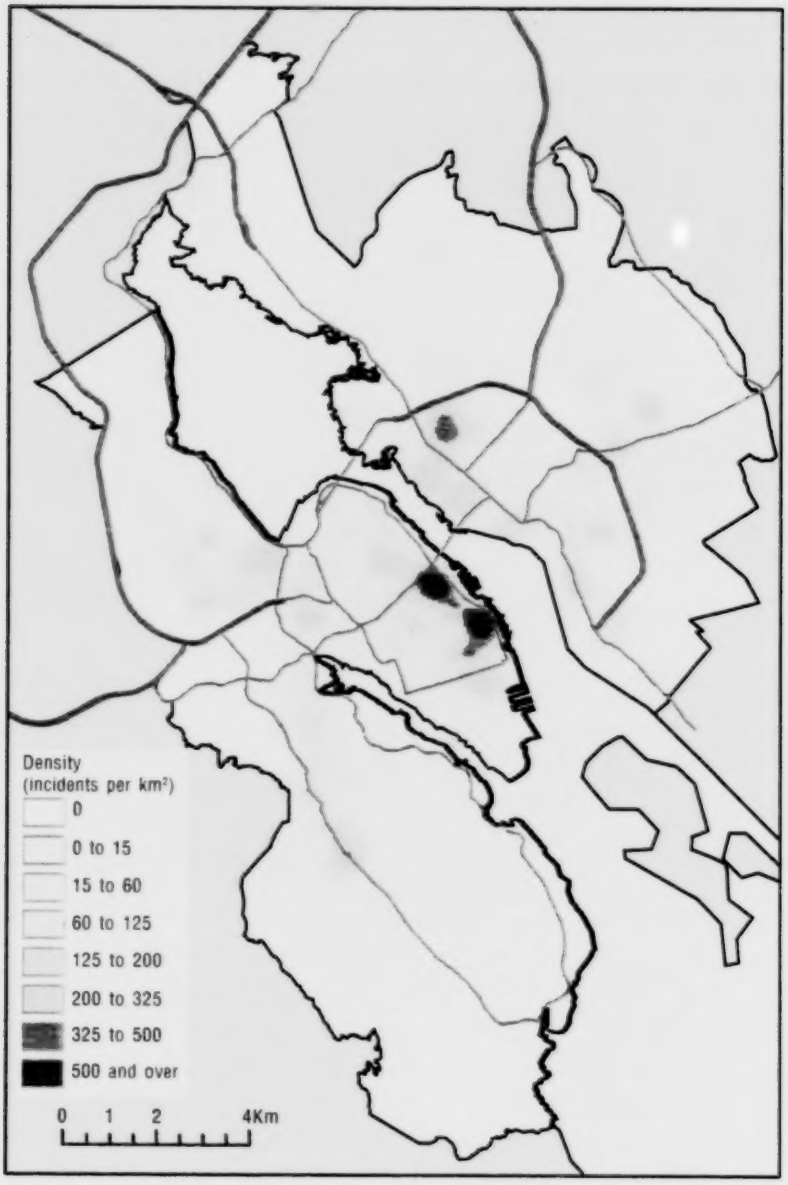
Offence categories included in this study are violent, property, drug, prostitution, offensive weapons, and gaming and betting offences. In 2001, the Halifax Regional Municipal Police reported nearly 21,000 of these selected offences, the vast majority of which were property crimes (77%), followed by violent offences (20%) and other offences (3%) including prostitution, drug-related offences, offensive weapons-related crimes and gaming and betting offences. This distribution of offences is relatively similar to the crime composition for Canada overall (79%, 17% and 4%, respectively).

Distribution of crime in the City of Halifax in 2001

Whereas incidents were reported in 50 of the 51 CTs that make up the area policed by the Halifax Regional Police Service (Table 2.1 and Table 2.2), a closer look at the distribution of incidents reveals that police-reported crime is not evenly distributed across the city but rather clustered in certain areas. Map 2.2 and Map 2.3 show violent and property crime hot spots in the city of Halifax area in 2001. Clusters of violent crime (Map 2.2) appear in the downtown area located near the harbour, as well as across the harbour to the east, in the area previously called the city of Dartmouth. Warm spots of violent crime also appear scattered throughout the city in various locations. The distribution of property crime incidents in Halifax (Map 2.3) is quite similar to the distribution of violent crime. One exception is two additional hot spots east of Halifax Harbour, located near two busy shopping centres.

Map 2.2

Kernel density distribution of violent crime incidents, Halifax, 2001

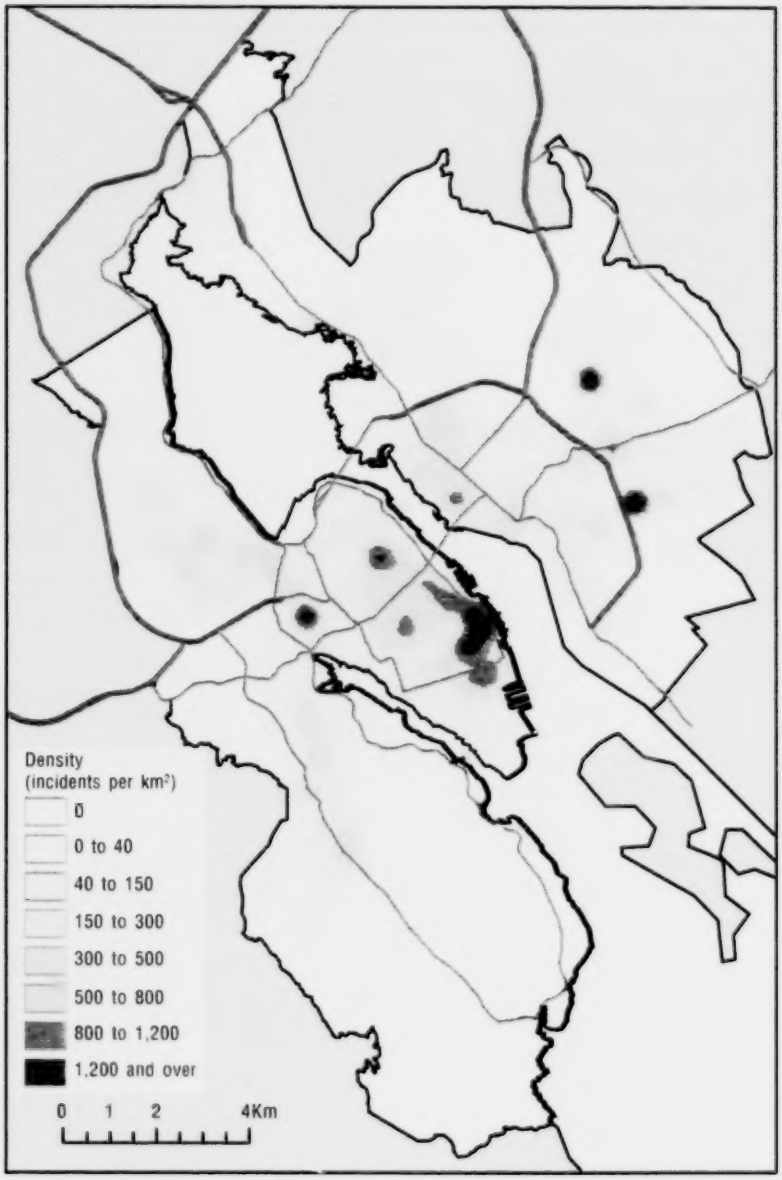


Based on 4,276 violent crime incidents.

Source: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001.

Map 2.3

Kernel density distribution of property crime incidents, Halifax, 2001



Based on 15,730 property crime incidents.

Source: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001.

The spatial distribution of crime in 2003 was approximately the same as in 2001. The increase in property crime was distributed among the same hot spots, and the concentrations of violent crime were almost identical. The data correlation coefficients at the CT level of 2001 and those of 2003 show the similarities; the correlation coefficient is 96% ($p<0.001$) for violent crime and 95% ($p<0.001$) for property crime. The crime data geocoded in 2001 seem to represent a definite general tendency of crime distribution in the city of Halifax area (Map 2.17 and Map 2.18 in "Appendix 2: Neighbourhood characteristics and the distribution of crime in Halifax").

It is important, however, to consider not just the relative distribution of crime across a city, but also to take the city's population into consideration. Map 2.4 and Map 2.5 illustrate crime distribution taking into account population at risk.[9] When Halifax's population at risk is included, many of the hot spots disappear and violent crime hot spots remain on either side of Halifax harbour, with similar results for property crime. Property crime warm spots continue to appear east of Halifax Harbour in the areas of the large shopping centres, as well.

Table 2.1

Count of police-reported crime incidents (CTs), census tracts, Halifax, 2001

Offences	Count of incidents[1]			
	Total all CTs	CT average	CT minimum	CT maximum
			number	
Total incidents[2]	20,776	407	0	1,358
Total violent incidents[2]	4,276	84	0	325
Total property incidents[2]	15,730	308	0	957
Drug incidents[2]	356	7	0	59
Other[2,3]	414	8	0	59
Selected offences				
Arson[4]	87	2	0	8
Assault level 1[4]	2,016	40	0	167
Assault levels 2 and 3[4]	410	8	0	47
Break and enter[4]	2,494	49	0	158
Motor vehicle theft[4]	1,394	27	0	103
Drug incidents[4]	391	8	0	64
Homicide[4,5]	8	0	0	2
Mischief[4]	2,862	56	0	186
Prostitution[4]	94	2	0	36
Robbery[4]	534	10	0	72
All sexual offences[4,6]	261	5	0	21
Theft under $5,000 (without motor vehicle theft)[4]	8,309	163	0	545
Theft over $5,000 (without motor vehicle theft)[4]	192	4	0	17

1. Total count based on the 51 CTs.
2. Includes most serious violation in each incident only.
3. Includes prostitution, offensive weapons, gaming and betting and other residual *Criminal Code* offences.
4. Includes all recorded violations in each incident.
5. Includes attempted murder and conspire to commit murder.
6. Includes sexual assault (levels 1 to 3) and other sexual violations.

Source: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001.

Table 2.2

Rates of police-reported crime incidents, census tracts (CTs), Halifax, 2001

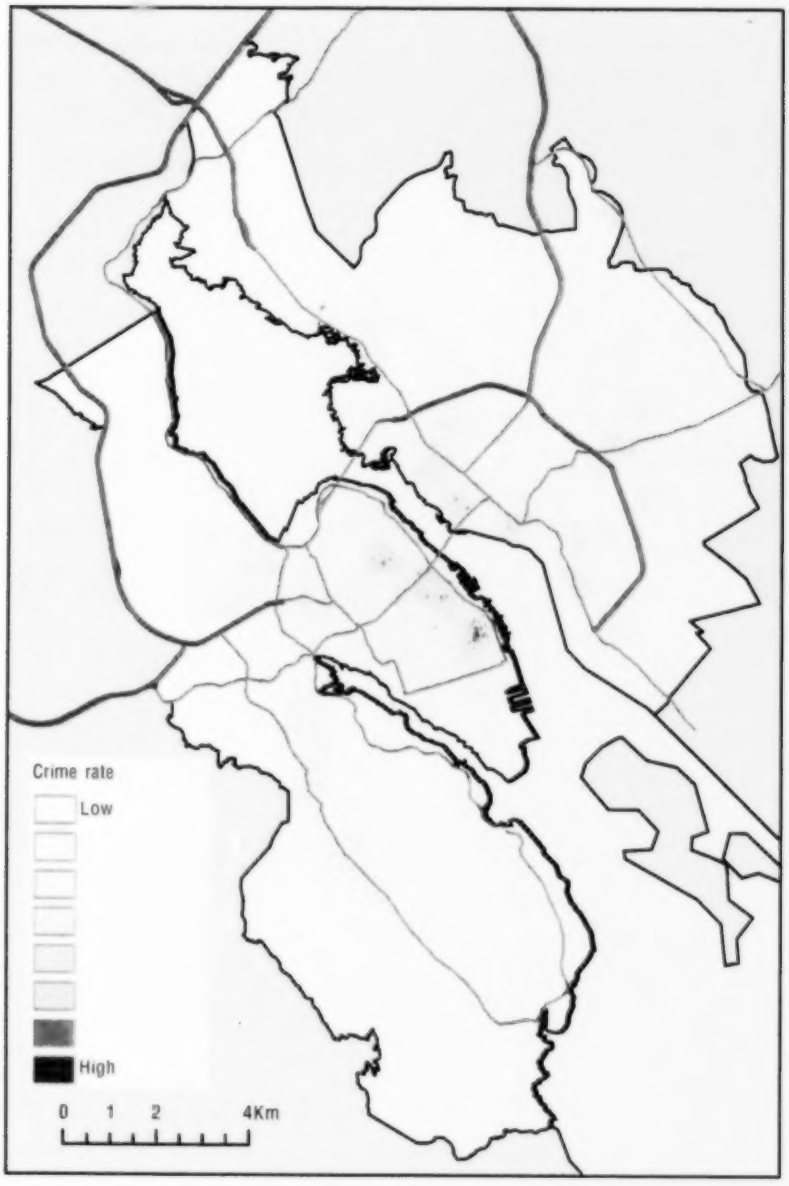
Offences	Rate of incidents per 1,000 residential population[1]			Rate of incidents per 1,000 residential and employed population[1]		
	CT average	CT minimum	CT maximum	CT average	CT minimum	CT maximum
	rate					
Total incidents[2]	123	0	781	66	0	174
Total violent incidents[2]	25	0	185	13	0	41
Total property incidents[2]	93	0	551	51	0	151
Drug incidents[2]	2	0	34	1	0	5
Other[2,3]	2	0	12	1	0	7
Selected offences						
Arson[4]	1	0	3	0	0	1
Assault level 1[4]	12	0	96	6	0	19
Assault levels 2 and 3[4]	2	0	27	1	0	5
Break and enter[4]	14	0	51	8	0	21
Motor vehicle theft[4]	8	0	22	5	0	12
Drug incidents[4]	3	0	37	1	0	5
Homicide[4,5]	0	0	1	0	0	0
Mischief[4]	16	0	107	9	0	17
Prostitution[4]	1	0	7	0	0	5
Robbery[5]	3	0	20	2	0	9
All sexual offences[4,6]	2	0	10	1	0	5
Theft under $5,000 (without motor vehicle theft)[4]	51	0	314	27	0	106
Theft over $5,000 (without motor vehicle theft)[4]	1	0	6	1	0	2

1. Total count based on the 51 CTs.
2. Includes most serious violation in each incident only.
3. Includes prostitution, offensive weapons, gaming and betting and other residual *Criminal Code* offences.
4. Includes all recorded violations in each incident.
5. Includes attempted murder and conspire to commit murder.
6. Includes sexual assault (levels 1 to 3) and other sexual violations.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Map 2.4

Kernel density distribution of violent crime incidents and population at risk, Halifax, 2001



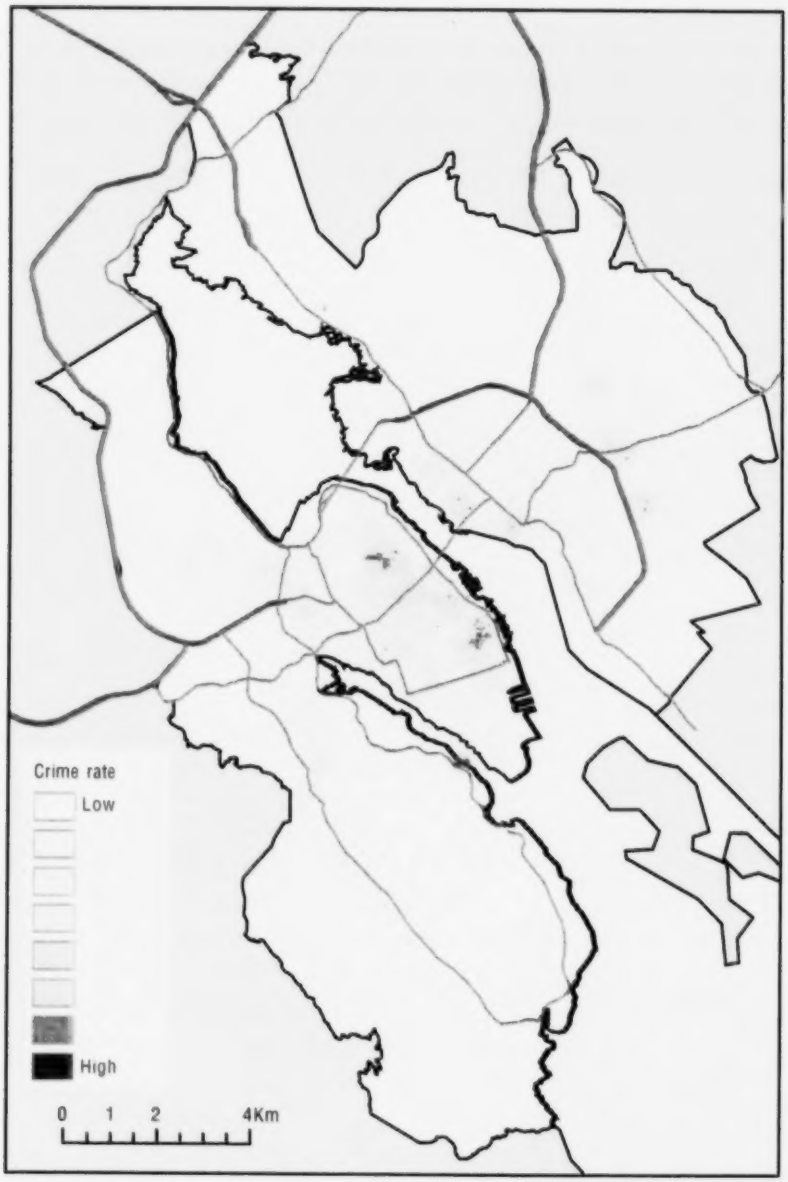
Based on 4,276 violent crime incidents.

Note: Local crime rates have been adjusted to ensure data confidentiality and to avoid introducing artificial hotspots where population at risk and crime densities are low.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Map 2.5

Kernel density distribution of property crime incidents and population at risk, Halifax, 2001



Based on 15,730 property crime incidents.

Note: Local crime rates have been adjusted to ensure data confidentiality and to avoid introducing artificial hotspots where population at risk and crime densities are low.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Neighbourhood characteristics and crime

This section explores the relationship between demographic, socio-economic, and land-use characteristics and 2001 rates of violent crime and property crime by population at risk in Halifax neighbourhoods.[10] The analysis makes use of total violent and property crime rates rather than looking at individual rates of specific offences in order to maximize the number of incidents being considered. It should not be concluded from the results of this study that some neighbourhood characteristics are the cause of crime; rather the results show that these factors are associated or co-occur with higher crime rates in neighbourhoods.

Descriptive results: a comparison of high- and lower crime neighbourhoods

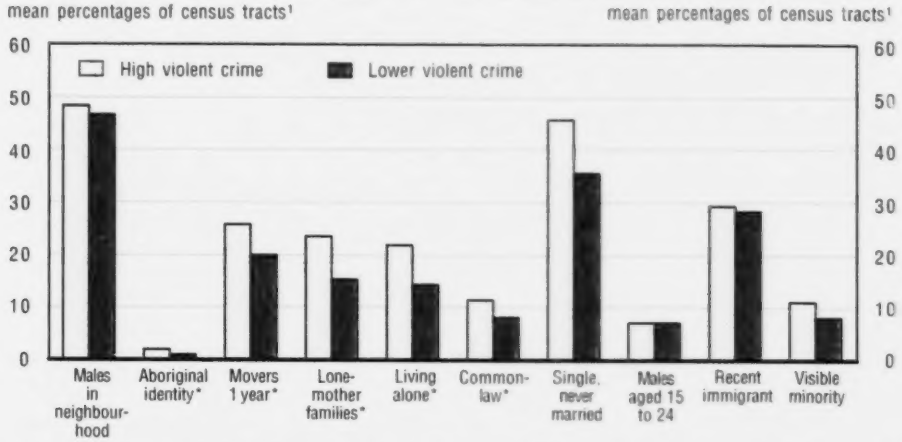
To examine the relationship between violent and property crime rates and selected neighbourhood characteristics, the 51 CTs have been divided into two groups for each crime type. The first group contains CTs falling into the highest 25% of property and violent crime rates, and the second group contains the remaining 75% of CTs. The differences are significant at $p<0.001$ unless otherwise indicated, based on an independent samples T-test.

Before controlling for other factors being studied, significant differences are noted in selected characteristics when comparing neighbourhoods with high crime rates to those with lower crime rates. For instance, when examining population characteristics, it can be seen that CTs with the highest rates of violent crime have significantly greater residential mobility, as indicated by the proportion of people who moved in the year preceding the census, compared to lower violent crime CTs (26% and 20% respectively) (Chart 2.2). The highest violent crime rate CTs also have significantly greater proportions of lone-mother families (23% and 15%, respectively), people living alone (22% and 15%, respectively), and people living in common-law situations (11% and 8%, respectively) than do their lower violent crime rate counterparts. There was no significant difference between high and lower crime neighbourhoods in terms of the proportion of young males living there.

Neighbourhoods with the highest property crime rates also display significant differences when compared to their lower property crime rate counterparts in terms of the proportion of people living alone or living in common-law situations (Chart 2.3).

Chart 2.2

Population characteristics in neighbourhoods with high and lower rates of violent crime, Halifax, 2001



* differences between high-crime and lower-crime means are statistically significant at: $p<0.001$.

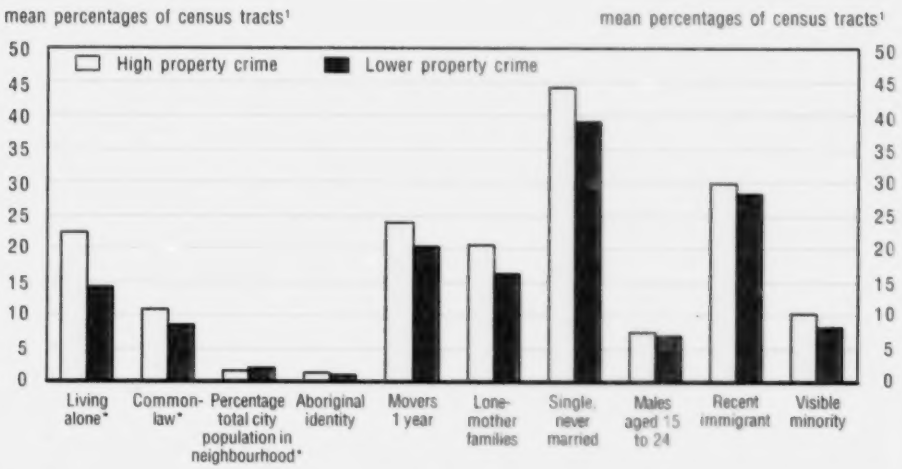
1. High-crime = census tracts falling into the highest 25% (13) of violent crime rate neighbourhoods; lower-crime = remaining 75% (38). Rate per 1,000 residential and employed population.

Note: N = 51 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Chart 2.3

Population characteristics in neighbourhoods with high and lower rates of property crime, Halifax, 2001



* differences between high-crime and lower-crime means are statistically significant at: $p<0.001$.

1. High-crime = census tracts falling into the highest 25% (13) of violent crime rate neighbourhoods; lower-crime = remaining 75% (38). Rate per 1,000 residential and employed population.

Note: N = 51 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

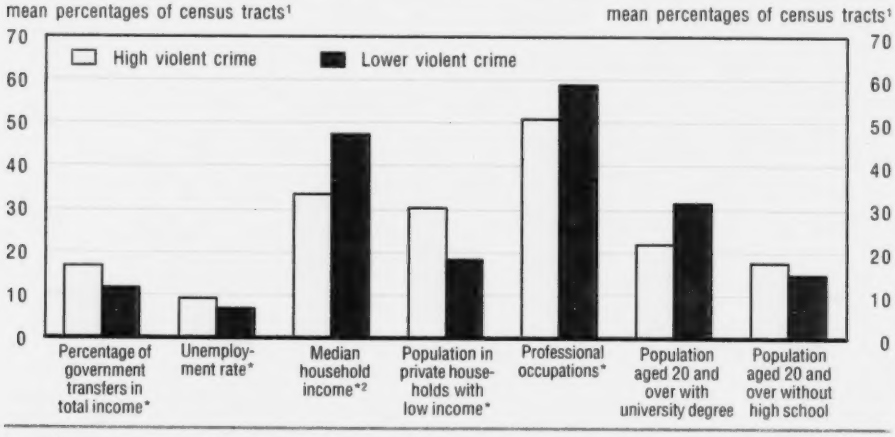
An examination of socio-economic characteristics also highlights a number of significant differences between the highest crime rate and lower crime rate CTs. The most significant differences are seen between the highest violent crime rate CTs and their lower violent crime rate counterpart (Chart 2.4). The highest violent crime rate CTs have a higher unemployment rate (9% and 7%, respectively), a higher proportion of people below the low income cut-off (30% and 18%, respectively) and a higher proportion of total income from government transfers (17% and 12%, respectively). They also have significantly lower median household incomes ($33,000 and $47,000, respectively) than their lower violent crime rate counterparts. Fewer significant differences in socio-economic characteristics were seen between the highest property crime rate CTs and lower property crime rate CTs, as seen in Chart 2.5.

Finally, Chart 2.6 and Chart 2.7 demonstrate differences between high-crime and lower-crime neighbourhoods in terms of land use and housing characteristics. In high violent crime areas, a slightly greater proportion of housing was in need of major repair (10%, and 7% in low violent crime areas, respectively), and a lower proportion was owner-occupied (15% and 22%, respectively) than in the lower violent crime rate CTs. Also, in high violent crime areas, a higher percentage of households spent more than 30% of their income on shelter (19% and 13%, respectively). The highest violent crime rate neighbourhoods had clearly greater proportions of commercial zoning.

There were fewer statistically significant differences in land-use and housing characteristics between the high and lower property crime areas. The highest property crime CTs had statistically significant greater proportions of households spending more than 30% of their revenue on housing (18% and 13%) and a greater amount of commercial zoning (20% and 7%) than the lower property crime CTs.

Chart 2.4

Socio-economic characteristics in neighbourhoods with high and lower rates of violent crime, Halifax, 2001



* differences between high-crime and lower-crime means are statistically significant at: $p<0.001$.

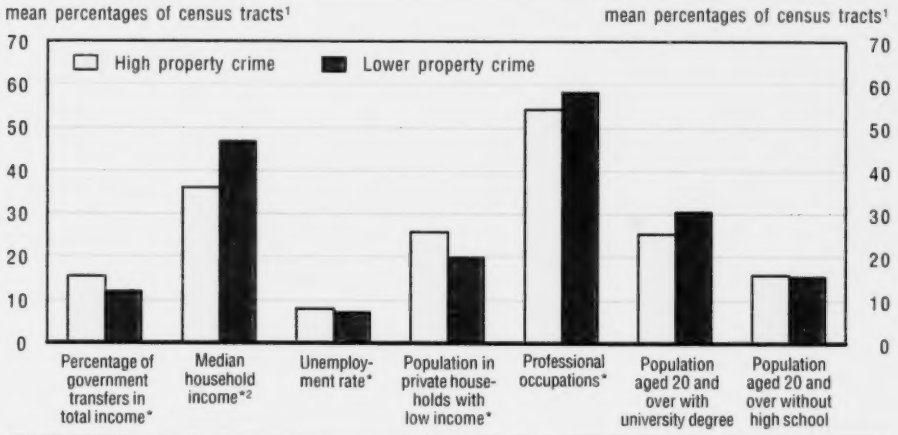
1. High-crime = census tracts falling into the highest 25% (13) of violent crime rate neighbourhoods; lower-crime = remaining 75% (38). Rate per 1,000 residential and employed population.
2. Median household income in $1,000s.

Note: N = 51 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Chart 2.5

Socio-economic characteristics in neighbourhoods with high and lower rates of property crime, Halifax, 2001



* differences between high-crime and lower-crime means are statistically significant at: $p<0.001$.

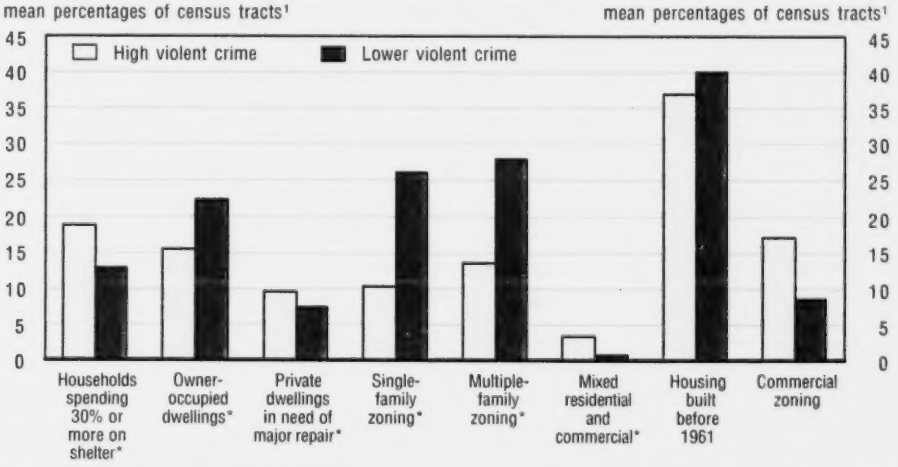
1. High-crime = census tracts falling into the highest 25% (13) of violent crime rate neighbourhoods; lower-crime = remaining 75% (38). Rate per 1,000 residential and employed population.
2. Median household income in $1,000s.

Note: N = 51 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Chart 2.6

Land-use and housing characteristics in neighbourhoods with high and lower rates of violent crime, Halifax, 2001



* differences between high-crime and lower-crime means are statistically significant at: $p<0.001$.

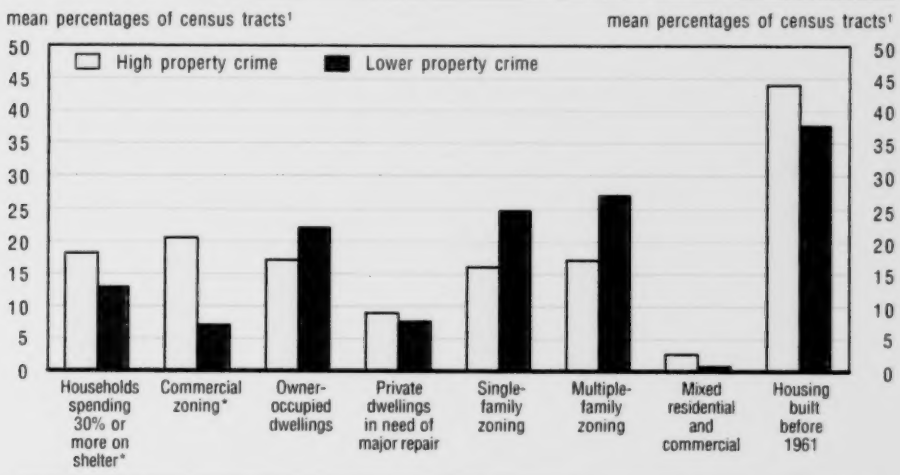
1. High-crime = census tracts falling into the highest 25% (13) of violent crime rate neighbourhoods; lower-crime = remaining 75% (38). Rate per 1,000 residential and employed population.

Note: N = 51 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001, Census, 2001 and City of Halifax Zoning Data.

Chart 2.7

Land-use and housing characteristics in neighbourhoods with high and lower rates of property crime, Halifax, 2001



* differences between high-crime and lower-crime means are statistically significant at: $p<0.001$.

1. High-crime = census tracts falling into the highest 25% (13) of violent crime rate neighbourhoods; lower-crime = remaining 75% (38). Rate per 1,000 residential and employed population.

Note: N = 51 census tracts.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001, Census, 2001 and City of Halifax Zoning Data.

Results of multivariate analysis

When considered individually, the neighbourhood characteristics discussed above are associated with violent and property crime, with some characteristics occurring in neighbourhoods with higher crime rates, and others occurring in neighbourhoods with lower crime rates. The strength of these associations can vary when multiple characteristics are considered together.

The presence of Halifax Harbour separates the city into two unique areas. To determine whether or not this would have an effect on the models, a location variable was introduced to indicate whether each CT fell into the area north-east of the harbour (formerly known as Dartmouth) or the area south-west of the harbour.[11] In both the property crime and violent crime models, this location variable was significant, indicating that a neighbourhood's location, either in the north-east or south-west area of the city, makes a difference to its crime rate. To determine if different factors are associated with crime rates in these two areas of the city, separate regression models were run for each area of the city.

Results of the regression models are shown in Table 2.3 and Table 2.4. The violent crime model for the north-east area of the city includes 3 explanatory variables, and results in an Adjusted R-Square value of 0.80, indicating that the model explains approximately 80% of the variation in violent crime rates in those neighbourhoods. The estimated regression coefficients (b) provide an indication of the relative contribution of each variable after controlling for the other variables in the model.

Table 2.3

Regression models for violent crime rates,[1] Halifax census tracts (CTs), 2001

	Halifax city[2,4]	North-East neighbourhoods[2,4]	South-West neighbourhoods[2,4]
Adjusted coefficients of determination (r^2)	0.48	0.8	0.6
Unstandardized regression coefficients (b)			
Lone-parent mother families[3]	0.30*	0.41*	0.33**
Neighbourhood population living alone[3]	0.52***	...	0.91***
Dwellings in need of major repair[3]	0.29*	...	0.30*
Commercial zoning[3]	...	0.32*	...
Population 20 and over with a Bachelor's degree[3]	...	-0.48**	...
North East-South West location variable	-0.49*	...	...

... not applicable
* p<0.05.
** p<0.01.
*** p<0.001.

1. Violent crime rates per 1,000 residential and employed population.
2. Halifax city based on 51 CTs. North-East neighbourhoods based on 19 CTs. South-West neighbourhoods based on 32 CTs.
3. Variables are standardized z-scores.
4. Regression models include intercept.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001, Census, 2001 and City of Halifax Zoning Data.

Table 2.4

Regression models for property crime rates,[1] Halifax census tracts (CTs), 2001

	Halifax city[2,4]	North-East neighbourhoods[2,4]	South-West neighbourhoods[2,4]
Adjusted coefficients of determination (r^2)	0.41	0.42	0.47
Unstandardized regression coefficients (b)			
Commercial zoning[3]	0.33*	0.33*	...
Households spending more than 30% of their income on shelter[3]	0.84**	...	1.36***
Median household income[3]	0.45*	...	0.60*
Unemployment rate[3]	...	0.30*	...
North East-South West location variable	-0.78*	...	...

... not applicable
* p<0.05.
** p<0.01.
*** p<0.001.

1. Property crime rates per 1,000 residential and employed population.
2. Halifax city based on 51 CTs. North-East neighbourhoods based on 19 CTs. South-West neighbourhoods based on 32 CTs.
3. Variables are standardized z-scores.
4. Regression models include intercept.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001, Census, 2001 and City of Halifax Zoning Data.

The crime rate regression model shows that the proportion of the population aged 20 and over with a bachelor's degree makes the largest relative contribution to the explanation of violent crime in the north-east area ($b=-0.48$, $p<0.01$). Therefore, as the proportion of the population holding a bachelor's degree increases in a neighbourhood, the violent crime rate decreases. This characteristic seems to offer protection against crime at the neighbourhood level. In contrast, the rate of violent crime is higher in areas with higher proportions of lone-parent mother families ($b=0.41$, $p<0.05$). The proportion of commercial zoning ($b=0.32$, $p<0.001$) is another factor that helps explain the variation in violent crime rates in the north-east neigbourhoods of Halifax. The greater the proportion of commercial zoning, the higher the violent crime rate in that neighbourhood.

The variables affecting violent crime rates in the south-west area of the city differ from those in the north-east. The violent crime model for the south-west includes only 3 explanatory variables, and results in an Adjusted R-Square value of 0.60, indicating that the model explains approximately 60% of the variation in violent crime rates in those neighbourhoods. The proportion of the neighbourhood population living alone makes the largest relative contribution to the explanation of violent crime rates in the south-west of the city ($b=0.91$, $p<0.001$). The next largest contribution is the proportion of lone-parent mother families ($b=0.33$, $p<0.01$), followed by the proportion of dwellings in need of major repair ($b=0.30$, $p<0.05$). As each of these factors increase in Halifax's south-west neighbourhoods, so do their violent crime rates.

The results of the property crime regression models also indicate a difference in which factors contribute to higher property crime rates on either side of the harbour. The property crime model for the north-east area includes two explanatory variables, and results in an Adjusted R-square value of 0.42. The largest relative contribution to the explanation of property crime rates in the north-east area of the city is made by the percentage of commercial zoning in a neighbourhood ($b=0.33$, $p<0.05$). The more commercial zoning a neighbourhood has, the higher the property crime rates. Neighbourhoods with higher proportions of people that are unemployed also have higher property crime rates ($b=0.30$, $p<0.05$).

The property crime regression model for the city's south-west area explains slightly more of the variation in property crime rates (47%) than the model for the north-east neighbourhoods, as indicated by an Adjusted R-square value of 0.47. The proportion of unaffordable shelter, as indicated by the proportion of the population spending more than 30% of their income on shelter, makes a significant contribution to the explanation of property crime rates in the south-west area of the city ($b=1.36$, $p<0.001$). However, the other variable making a significant contribution to the explanation of the variation in crime rates in this part of the city is median household income ($b=0.60$, $p<0.05$). As the median household income in a neighbourhood increases, so do property crime rates. While having these two income-related measures being significant in the same model appears somewhat contradictory, that isn't necessarily the case. It may be that some households in Halifax with relatively high incomes spend more than 30% of that income on shelter.

Summary of findings – Halifax

In Halifax, property and violent crime hot spots were located largely in the city's downtown area and east of Halifax Harbour. When all other neighbourhood characteristics are taken into account, results indicate that the factors linked to the variation in neighbourhood crime rates based on the population at risk are different in areas north-east of Halifax Harbour than they are in the areas south-west of the harbour.

In fact, violent crime rates on either side of the harbour are higher in neighbourhoods with more single-mother families. These families tend to be living in low-income situations. Violent crime rates north-east of the harbour also occur in neighbourhoods with larger proportions of commercial zoning and populations with lower levels of education. In the area south-west of the harbour, violent crime rates occur in neighbourhoods where more people live alone, and the housing situation is poor, as indicated by the proportion of houses in need of major repairs.

Property crime rates in the north-east area are higher in neighbourhoods with more commercial zoning and higher rates of unemployment. On the south-west side of the harbour, a neighbourhood's property crime rate increases with higher proportions of households spending more than 30% of their income on housing, as well as higher median household incomes.

Endnotes

5. These population figures are based on the Statistics Canada census metropolitan area (CMA) population for Halifax, and are used for national comparative purposes. The CMA boundary includes adjacent municipalities situated around the urban core and is consequently larger than the study area.
6. A small portion of the area services by the Halifax Regional Police is excluded from this study because of a discrepancy between police service and Census Tract boundaries. The residential population of this area is 6,380 people, which is less than 3% of the population policed by the Halifax Regional Police Service.
7. The neighbourhoods used in this analysis correspond to Census Tracts (CTs), which are small, relatively stable geographic units that usually have residential populations between 2,500 and 8,000 people, and are located within census metropolitan areas.
8. Halifax Regional Municipality. 2006. "Halifax Regional Police" http://www.halifax.ca/Police/PatrolAreas/index.html
9. To obtain more detailed information on the use of the population at risk in the spatial crime data analysis, see the Methodology section.
10. The definition of the term 'neighbourhood' used in this study reflects the census tracts (CTs). For additional information, see the Methodology section.
11. The city was divided into a North-East section made up of 19 CTs, and a South-West section made up of the remaining 32 CTs.

Neighbourhood characteristics and the distribution of crime in Thunder Bay

By Mathieu Charron, Statistics Canada

Thunder Bay in context

In 2001, the Thunder Bay census metropolitan area (CMA) was the least populated of Canada's 27 CMAs, with a population of 121,986. Whereas the population of Ontario grew 6.1% from 1996 to 2001, the population of Thunder Bay declined 3.7%. According to the 2006 Census, the population of the Thunder Bay CMA (122,907) has stabilized since then, with a slight increase of 0.8% since 2001.

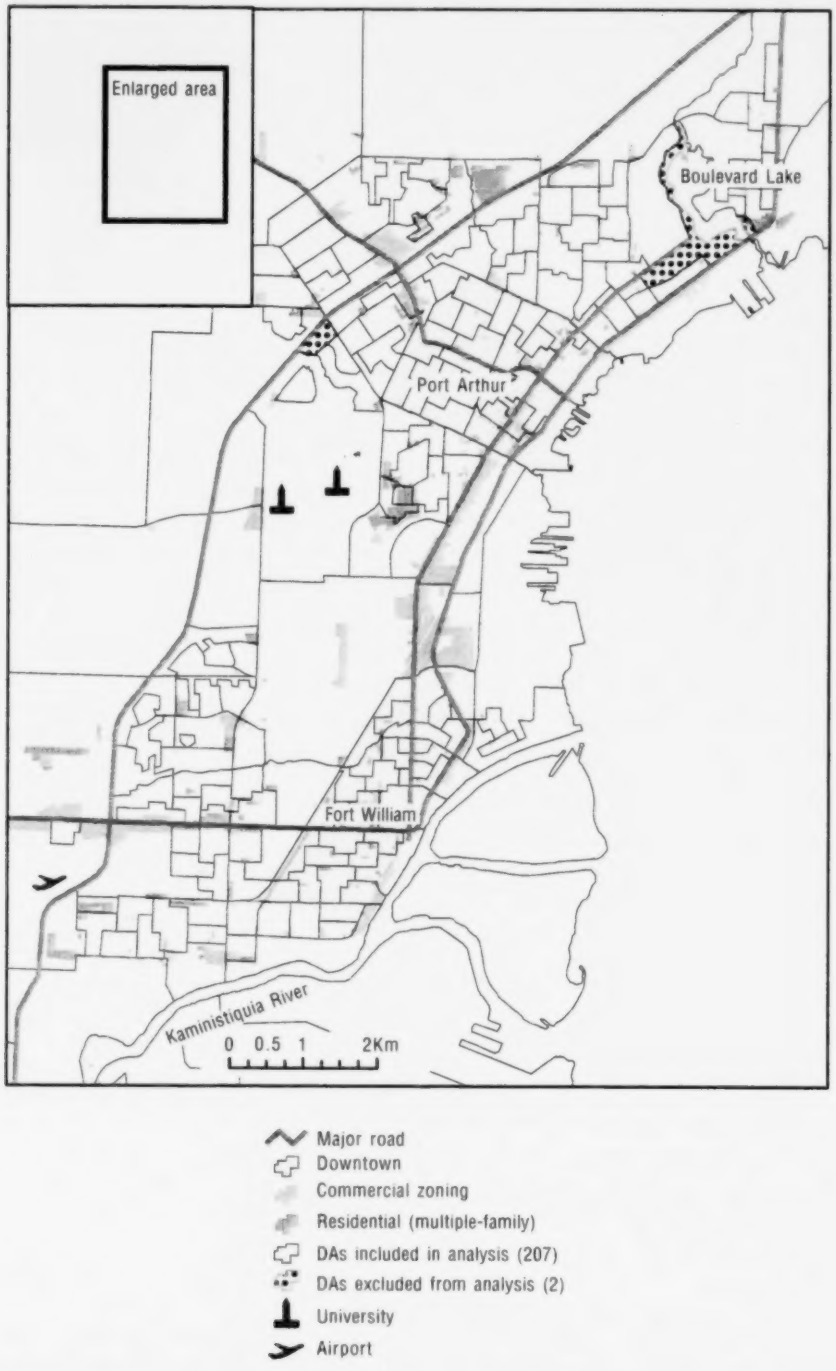
Thunder Bay is the largest urban area in all of Northwestern Ontario. The closest CMAs are more than 1,000 kilometres east (Sudbury) and 700 kilometres west (Winnipeg). Located on the edge of the Great Lakes navigation system, Thunder Bay, sometimes called the Lakehead, has, since its founding, been a necessary link for the transit of goods and people between Eastern and Western Canada.

The City of Thunder Bay has two downtowns, Fort William and Port Arthur. Fort William was founded in the seventeenth century at the mouth of the Kaministiquia River, whereas Port Arthur developed in the nineteenth century at the place where the Canadian Pacific meets Lake Superior, approximately six kilometres north of Fort William. In January 1970, these two towns were merged with the municipalities of Neebing and McIntyre to form the City of Thunder Bay. Since then, part of the financial, commercial and institutional activity has shifted from the downtowns of Fort William and Port Arthur to the Intercity area, which consists of shopping malls, megastores, Lakehead University, Confederation College and industrial zones (Map 3.1).

During the 1990s, the crime rate for the Thunder Bay CMA followed the downward trend observed nationwide, although it remained higher than the rate for Canada overall (Chart 3.1). In 2001, the crime rate for the Thunder Bay CMA ranked ninth with 8,408 crimes per 100,000 inhabitants, ahead of the CMAs of Calgary (7,140) and Sudbury (6,285) but behind the CMAs of Winnipeg (11,033) and Regina (16,402).

Map 3.1

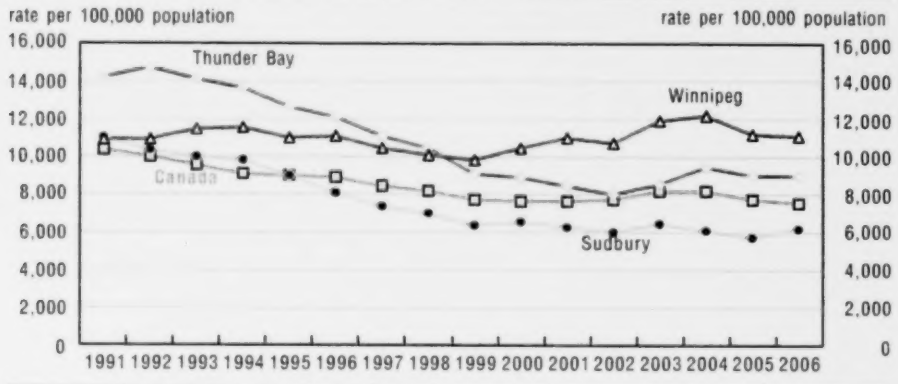
Local context and dissemination areas (DAs), Thunder Bay, 2001



Sources: Statistics Canada. Census. 2001 and City of Thunder Bay. Planning Division.

Chart 3.1

Crime rates[1] in selected census metropolitan areas, Canada, 1991 to 2006



1. Rates based on count of total *Criminal Code* incidents excluding traffic offences.

Source: Statistics Canada, Canadian Centre for Justice Statistics, Uniform Crime Reporting Survey, 1991 to 2006.

According to the 2004 General Social Survey on victimization, residents of Thunder Bay CMA reported 322 victimization incidents per 1,000 households. The rate was not significantly different from the Canadian rate of 248 victimization incidents per 1,000 households (Gannon and Mihorean 2005).

The City of Thunder Bay, which is the focus of this study, is situated at the centre of the CMA that bears its name. In 2001, it had a population of 109,000, distributed over an area of approximately 325 square kilometres divided into 209 neighbourhoods or dissemination areas,[12] which gives it a density of 332 inhabitants per square kilometre. This area is entirely served by the Thunder Bay Police Service. In 2001, the service had 212 officers distributed among 11 neighbourhood stations and a headquarter (Logan, 2002).

Offence categories included in this study are violent, property, drug, prostitution, offensive weapons, and gaming and betting offences. In 2001, the Thunder Bay Police Service reported 8,190 of these selected offences, the vast majority of which were property crimes (70%), followed by violent crimes (24%) and other crimes (6%). This distribution was slightly different than the one noted at the national level (79%, 17% and 4%, respectively). The proportion of violent crime, as reported by the police department, was slightly higher.

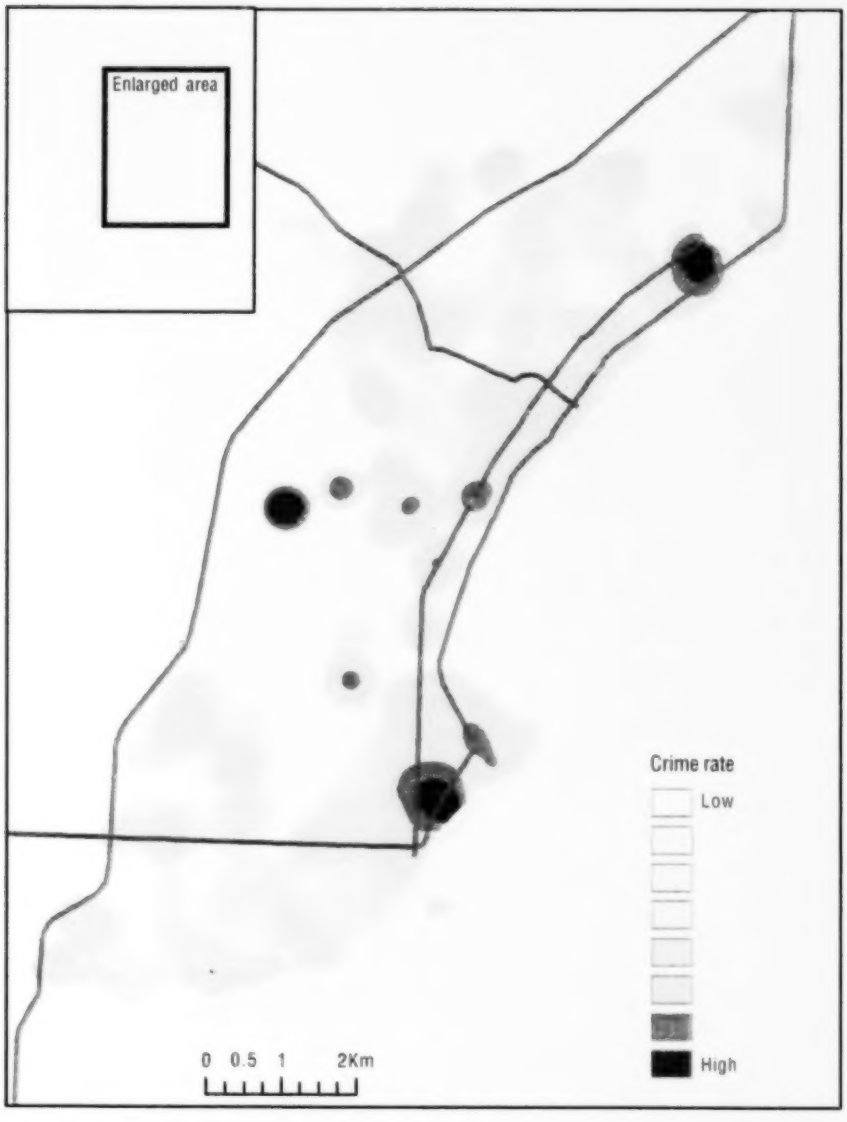
Distribution of crime in the City of Thunder Bay in 2001

Map 3.2 and Map 3.3 illustrate the kernel density distribution of crime incidents according to the population at risk[13] within the City of Thunder Bay in 2001. These maps, which show local crime rates, illustrate how crime is concentrated in certain areas of the city.

Local incident rates for violent and property crimes exhibit similar geographic concentrations: they follow a north-south axis bordering Lake Superior and then the Kaministiquia River, with greater concentrations in the former cities of Fort William and Port Arthur. In addition to linking the two former city centres, this north-south axis includes several nodes of commercial activity (shopping malls and megastores). Violent crime and property crime incidents are relatively rare in the outlying areas of the municipality.

Map 3.2

Kernel density distribution of violent crime incidents and population at risk, Thunder Bay, 2001



Based on 1,541 violent crime incidents.

Note: Local crime rates have been adjusted to ensure data confidentiality and to avoid introducing artificial hotspots where population at risk and crime densities are low.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Map 3.3

Kernel density distribution of property crime incidents and population at risk, Thunder Bay, 2001

Based on 4,717 property crime incidents.

Note: Local crime rates have been adjusted to ensure data confidentiality and to avoid introducing artificial hotspots where population at risk and crime densities are low.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

The Fort William city centre has 67% more violent crime and 75% more property crime than the Port Arthur city centre (Table 3.1). Local crime rates diminish as a function of their distance from the nearest city centre[14] (Chart 3.2). In fact, the crime rate—for both violent crime and property crime—within one kilometre of either of the city centres is twice as high as the rate more than five kilometres from those centres.

Table 3.1

Characteristics of the central neighborhoods of Port Arthur and Fort William, 2001

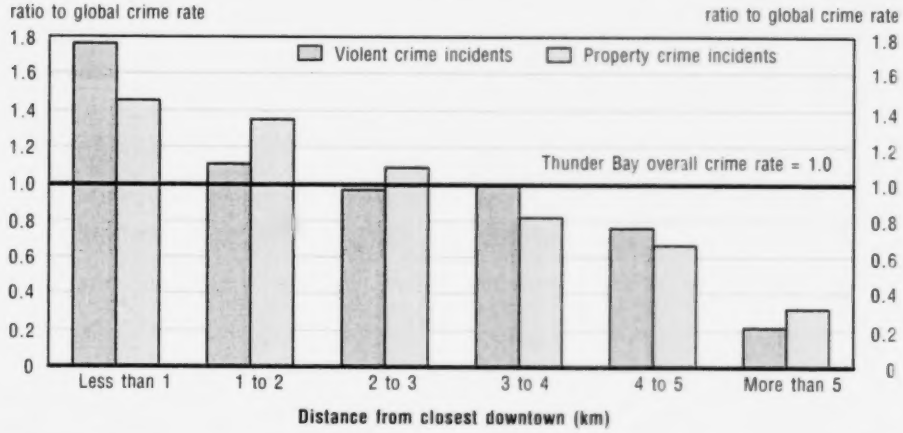
Characteristics	Port Arthur	Fort William
Incident count	number	
Total incidents***	875	1,613
Violent indicents***	222	394
Property incidents***	603	1,119
Crime rate per 1,000 residential and employed population	rate	
Total incidents***	43.7	75.7
Violent indicents***	11.1	18.5
Property incidents***	30.1	52.5
Density	density	
Residential population (per km²)	2,558	2,805
Employed population (per km²)	1,532	1,456
	percentage	
Zoning		
Commercial	15.6	17.5
Residential (single- and multiple-family)	69.5	62.3
Dwellings		
Built before 1961	69.0	76.1
Built after 1990	3.3	2.4
Demography		
Aged 15 and under	14.9	16.6
Aged 65 and over	20.7	16.9
Single, never married	36.0	37.7
Lone-parent families**	10.1	14.2
Aboriginal population*	6.8	9.4
Economic status		
Owner-occupied dwellings**	62.2	59.6
Low income households**	18.2	21.7
	dollars	
Average employment income*	$28,898	$25,385

* p<0.1.
** p<0.05.
*** p<0.01.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Chart 3.2

Crime rate by distance from the closest downtown, Thunder Bay, 2001



Source: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001.

The spatial distributions of the local rates of property crimes and violent crimes exhibit a few differences (Map 3.2 and Map 3.3). Property crime incidents were more concentrated in shopping malls and megastores. This is especially true for theft under $5,000, which account for nearly half of property crimes. Motor vehicle thefts are concentrated in commercial locations but are also grouped in non-commercial areas.[15]

The largest concentrations of violent incidents are in areas that include several apartment buildings. Actually, nearly two-thirds of violent incidents consist of assaults (1,087 out of 1,669) dispersed over the entire residential area, with a few groupings in specific neighbourhoods that have a number of multiple-unit residential buildings.

The spatial distribution of violent crime and property crime in 2003 is similar to that in 2001. Accordingly, the coefficients of correlation between the 2001 and 2003 data are high, at 0.89 for violent crime incidents and 0.96 for property crime incidents ($p<0.001$). These similarities may be seen in various maps in the document "Appendix 3: Neighbourhood characteristics and the distribution of crime in Thunder Bay" (Map 3.6 and Map 3.8).

Neighbourhood characteristics and crime

The descriptive analyses above show that crime is concentrated in a limited number of hot spots, and the location of these hot spots varies depending on whether one is looking at property or violent crime. The analyses below focus more on neighbourhood characteristics and their association with variations in crime as reported across the City of Thunder Bay. However, it should not be concluded from the analyses that some neighbourhood characteristics are the cause of crime; rather the results show that these factors are associated with or co-occur with higher crime rates in neighbourhoods.

In 2001, the Thunder Bay Police Service reported crime incidents in each of the 207 dissemination areas (DAs) covered by the study. However, these crime incidents were concentrated in particular DAs or neighbourhoods of the city. In fact, more than one-quarter of violent crime and property crime incidents were recorded in fewer than 10 DAs.

Descriptive results: a comparison of high- and lower-crime neighbourhoods

To examine the relationships between crime rates and various neighbourhood characteristics, DAs are classified into quartiles depending on their crime rate (Table 3.2). The spatial distribution of the quartiles (Map 3.4) is similar to that of the hot spots, studied earlier (Map 3.2 and Map 3.3). With a few exceptions, the high-crime DAs are concentrated near the city centres of Fort William and Port Arthur. Because of the strong similarity between the results for violent crimes and those for property crimes, only the results for violent crimes will be discussed. The differences are significant at $p<0.001$, unless otherwise indicated, based on an independent samples test.

Table 3.2

Quartiles defined by crime rates,[1] Thunder Bay, 2001

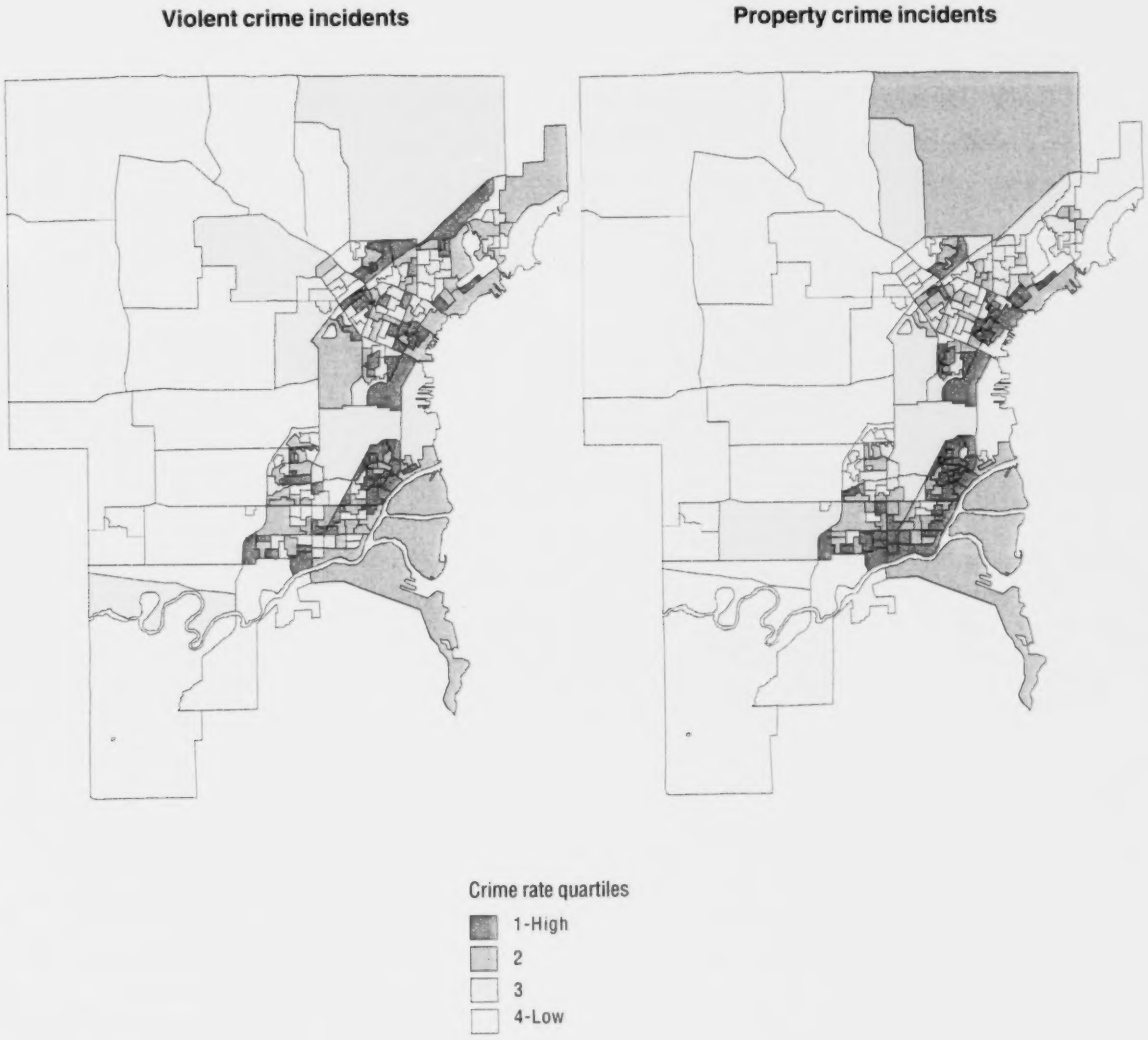
		Violent crime rate		Property crime rate	
Quartile	Dissemination areas	Minimum	Maximum	Minimum	Maximum
	number		rate		
1	52	14.7	64.0	38.0	275.9
2	52	7.2	14.4	23.9	37.6
3	52	4.0	7.1	13.6	23.3
4	53	0.0	3.9	1.8	13.5

1. Rate per 1,000 resident and working population.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

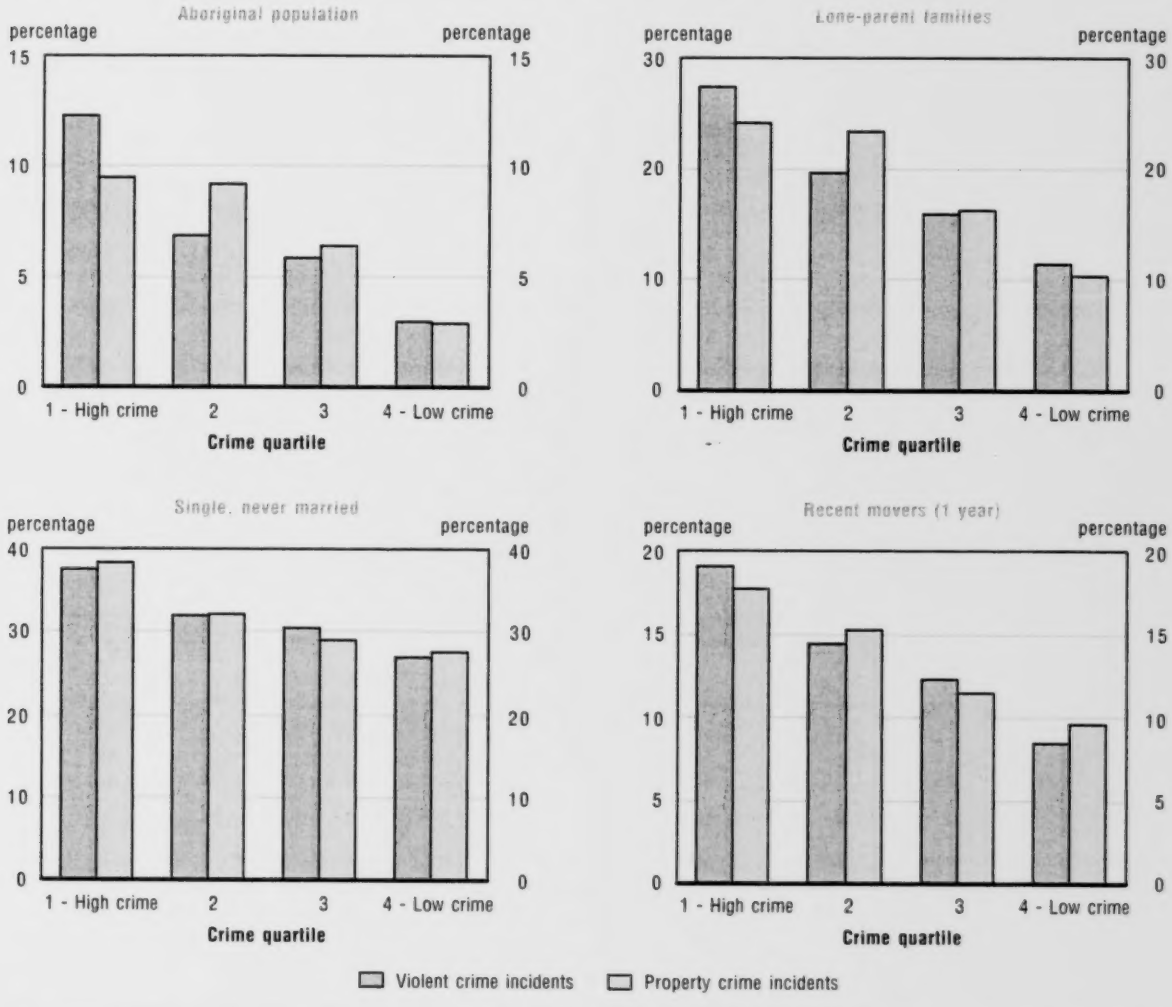
High- and lower-crime neighbourhoods differ according to the demographic characteristics of their residents. Before controlling for other factors, high-crime neighbourhoods have larger proportions of Aboriginals (12% in high-crime neighbourhoods compared to 3% in lower-crime neighbourhoods), lone-parent families (27% compared to 11%), single people (38% compared to 27%) and people who moved in the year preceding the census (19% compared to 8%) than neighbourhoods with lower rates of violent crime and property crime (Chart 3.3).

Map 3.4
Spatial distribution of quartiles of crime rates, Thunder Bay, 2001



Source: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, 2001.

Chart 3.3
Population characteristics and crime quartile, Thunder Bay, 2001



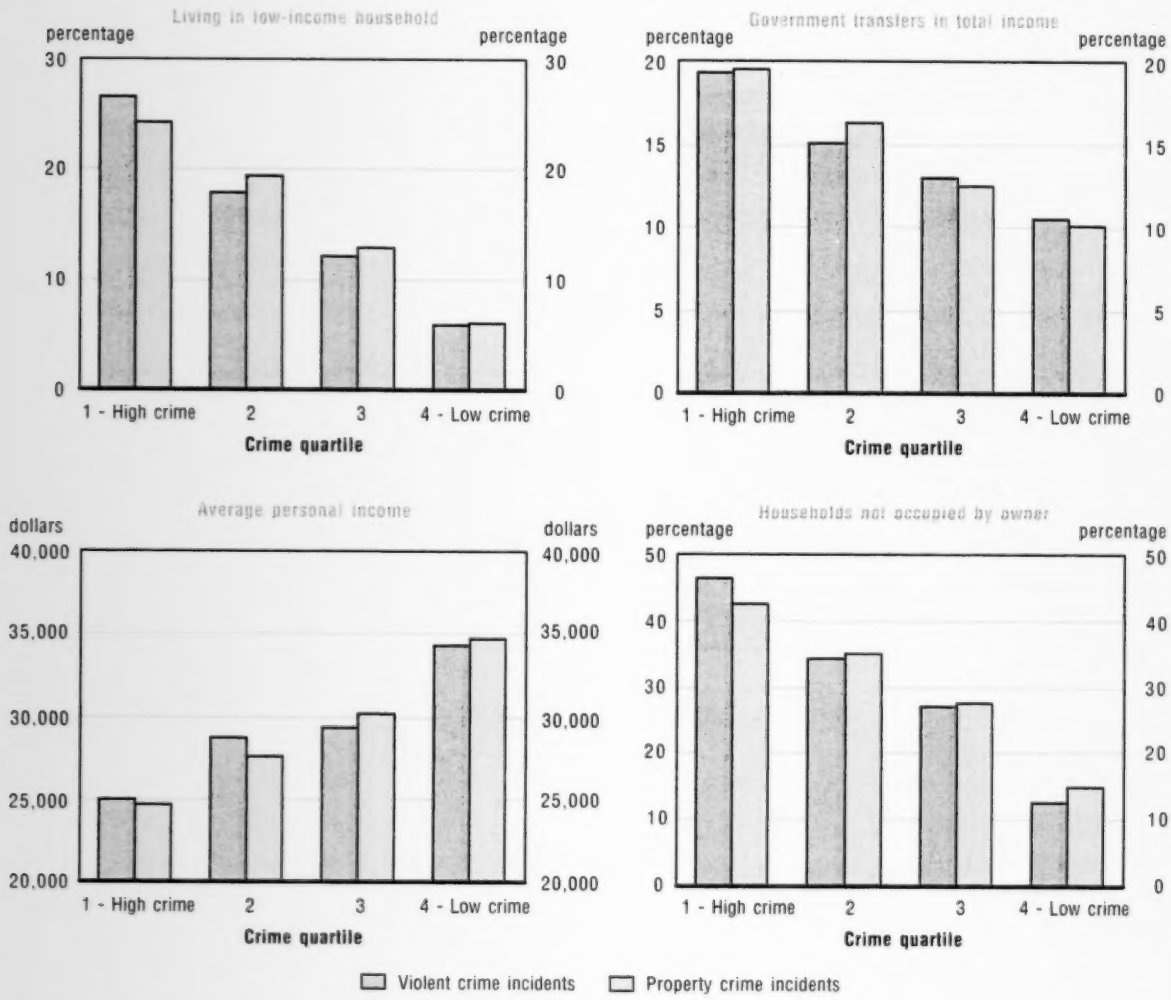
Notes: Differences between quartile are statistically significant at: $p<0.001$.
Rate per 1,000 residential and employed population.
N = 207 dissemination areas.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

High- and lower-crime DAs also differ in the socio-economic characteristics of their residents (Chart 3.4). The income of residents of high-crime DAs is, on average, $10,000 lower than for residents of lower-crime DAs. Also, government transfers account for more than 20% of the total income of high-crime DAs, whereas it comprises only 10% of that of lower-crime DAs. Lastly, the proportion of individuals who belong to a low-income household (27%) is four times higher in high-crime DAs than in lower-crime DAs (6%), while the proportion of renters is three times higher (46% compared to 13%).

Chart 3.4

Socio-economic characteristics and crime quartile, Thunder Bay, 2001

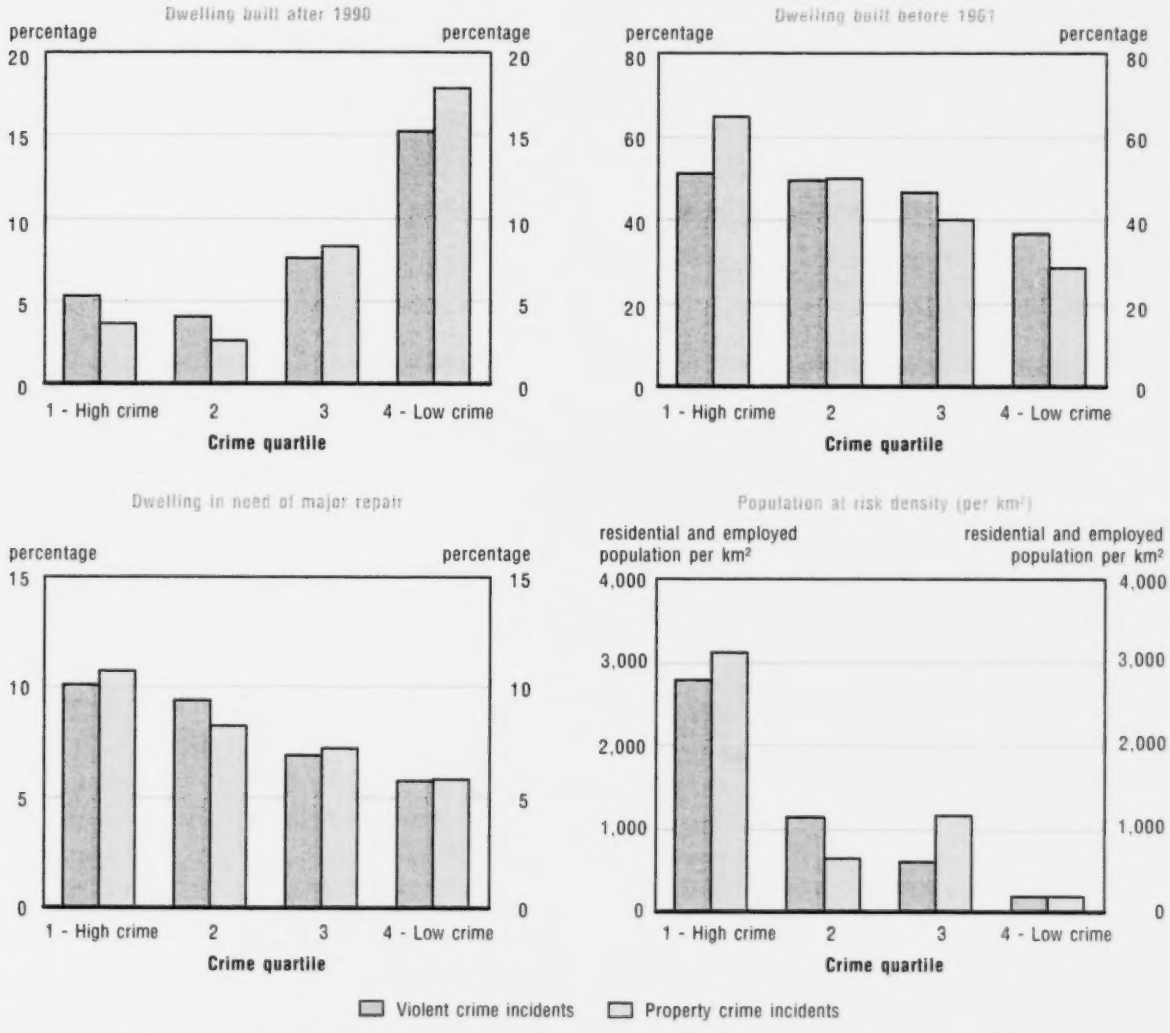


Notes: Differences between quartile are statistically significant at: $p<0.001$.
Rate per 1,000 residential and employed population.
N = 207 dissemination areas.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

For both violent crime and property crime, high- and lower-crime DAs differ in the characteristics of their dwellings (Chart 3.5). Compared to lower-crime DAs, high-crime DAs have more dwellings that are older and in poorer condition, a lower proportion of dwellings built after 1990 (5% compared to 15% in lower-crime neighbourhoods), a higher proportion of dwellings requiring major repairs (10% compared to 6%) and they are more densely populated (2,800 inhabitants and workers per km² compared to 200 for lower-crime DAs).

Chart 3.5
Dwelling characteristics and crime quartile, Thunder Bay, 2001



Notes: Differences between quartile are statistically significant at: $p<0.001$.
Rate per 1,000 residential and employed population.
N = 207 dissemination areas.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001 and Census, 2001.

Table 3.3 shows variations in the crime rate according to selected zoning categories.[16] In Thunder Bay, commercial zoning exhibits much higher crime rates than other zoning categories. In fact, nearly one-quarter of property crimes were committed in a commercial-zoned area, whereas these places accounted for only 7.4% of the population at risk and 1.5% of the total area of the municipality. The multi-family zoning category ranks second for all types of incidents. The lowest incident rates are for the "open space" and "industrial" categories.

Table 3.3

Crime rate by zoning categories, Thunder Bay, 2001

	Crime rate (per 1,000 residential and employed population[1])						
Crime rates	All usages	Commercial	Open space	Industrial	Public space	Multiple-family residential	Single-family residential
Total incidents	42	135	13	17	37	47	25
Violent incidents	10	28	3	2	12	13	5
Property incidents	30	100	9	14	22	33	19

1. Population at risk for each zoning category has been estimated from block's population.

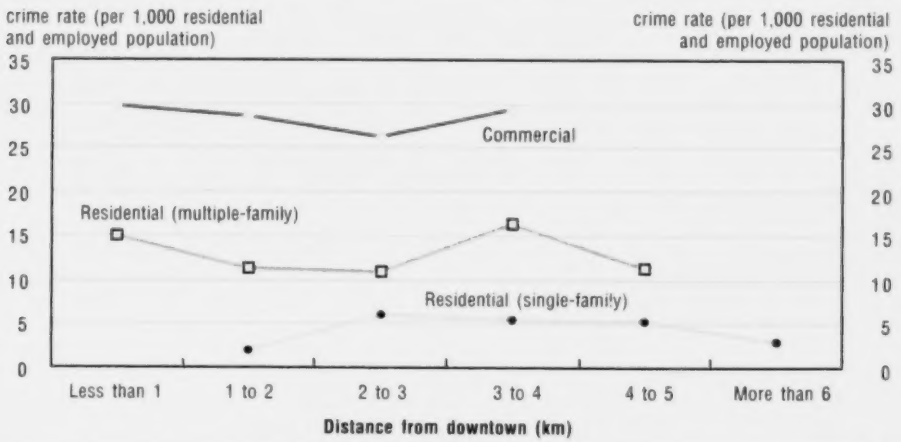
Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001, Census, 2001 and City of Thunder Bay, Planning Division, 2005.

Crime rates are higher near the city centres, where commercial and economic activities are concentrated. Chart 3.6 and Chart 3.7 show that crime rates by zoning category do not necessarily diminish according to distance from the city centre. Thus, it appears that zoning categories account for variations in crime rates better than distance from a city centre. Crime rates associated with the "commercial" category are consistently much higher than those associated with the "multi-family residential" and "single-family residential" categories.

The spatial distribution of crime rates in Thunder Bay appears to be associated with urban development and the resulting differentiation of neighbourhoods. The population of the core neighbourhoods has an older age structure and higher proportions of single people and Aboriginals than does the population of outlying neighbourhoods. On average, residents who live more than six kilometres from a city centre have a 50% higher income than residents living less than one kilometre's distance. The further from a city centre, the lower the proportions of lone-parent families and individuals belonging to a low-income households (Table 3.4).

Chart 3.6

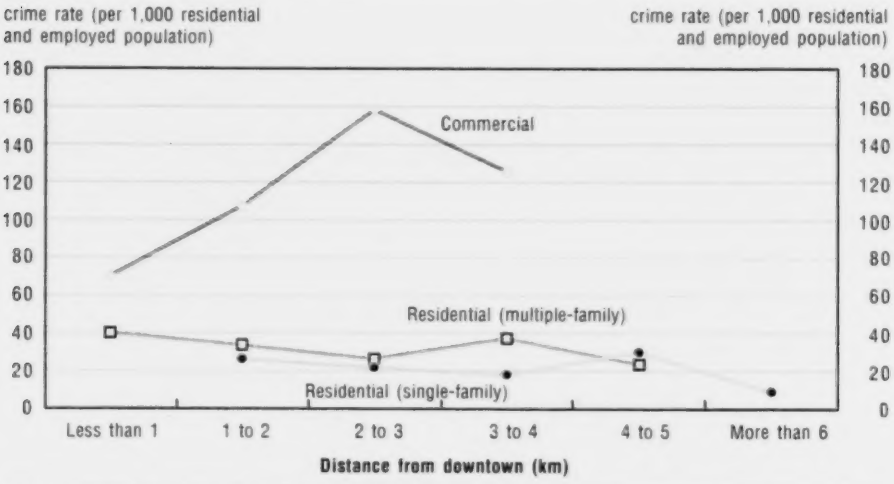
Violent crime rate by zoning and distance from downtown, Thunder Bay, 2001



Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001, Census, 2001 and City of Thunder Bay Zoning Data.

Chart 3.7

Property crime rate by zoning and distance from downtown, Thunder Bay, 2001



Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001, Census, 2001 and City of Thunder Bay Zoning Data.

Also, since the expansion of the city began in the city centres, the oldest dwellings are located there, whereas the most recent dwellings are built on the periphery. These differences are matched with differences between the two city centres: downtown Port Arthur has fewer old dwellings and fewer single people, lone-parent families, Aboriginals, renters and people belonging to a low-income household. Also, inhabitants of downtown Port Arthur have, on average, a personal income $3,000 higher than inhabitants of downtown Fort William (Table 3.4).

Results of multivariate analysis

The above analyses have shown that some demographic, socio-economic and land-use characteristics of neighbourhoods, considered in isolation, are related to higher crime rates, but the strength of these relationships may vary when several characteristics are considered together. In this section, multivariate analysis is used to examine the association between neighbourhood characteristics and crime levels, controlling for other characteristics.[17]

Table 3.4

Neighborhood characteristics and distance from the nearest downtown, Thunder Bay, 2001

Neighborhood characteristics	Less than 1 km	1 to 2 km	2 to 3 km	3 to 4 km	5 to 6 km
			density		
Density					
Residential population (per sq km)	2,073	1,644	1,127	1,121	402
Employed population (per sq km)	2,303	524	521	483	144
			percentage		
Zoning					
Commercial zoning	27.4	4.6	7.2	4.9	3.2
Residential (multiple-family)	38.9	46.2	29.3	17.6	11.0
Residential (single-family)	2.4	8.3	15.4	51.7	76.6
Dwellings					
Built before 1961	64.8	75.4	44.1	22.3	35.6
Built after 1990	4.7	2.1	2.8	8.8	19.9
Demography					
Aged 15 and under	13.9	17.1	17.2	19.7	20.0
Aged 65 and over	20.5	18.0	19.1	12.9	12.4
Single, never married	41.7	32.9	30.8	30.5	28.8
Lone-parent families	25.3	21.9	19.6	17.2	14.6
Economic status					
Owner-occupied dwellings	44.7	70.9	65.9	71.1	82.5
Low-income households	27.7	16.2	17.3	14.4	11.4
			dollars		
Average employment income	$24,275	$28,681	$27,309	$30,116	$30,873

Note: Overall difference between groups defined by distance from downtown is significant for all shown variables (<0.001), according to variance analysis.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001, Census, 2001 and City of Thunder Bay, Planning Division, 2005.

To assess the relative contribution of neighbourhood characteristics to the explanation of crime, the set of variables was regressed separately on violent and property crime rates. The results are shown in Table 3.5. The modeling process reveals three variables that explain the variation in violent crimes and three variables that explain property crimes.

The regressive model for violent crimes has a coefficient of determination of 0.46. The estimated regression coefficients provide an indication of the relative contribution of each variable, while controlling for the other variables in the model.

The violent crime rate model shows that the proportion of single people in a neighbourhood has the greatest explanatory power ($b = 0.35$, $p<0.001$). Rates of violent crime are higher in neighbourhoods with a larger proportion of single people. Violent crime rates are also higher where government transfers comprise a larger proportion of total income ($b = 0.23$, $p<0.001$) and where there is a larger proportion of residents living in low-income households ($b = 0.23$, $p<0.01$). Variations in crime in Thunder Bay at the neighbourhood level are therefore statistically associated with the proportion of single people and people with less favourable economic resources.

In turn, the model for property crime rates registers a squared correlation coefficient of 0.45 between observed values and predicted values for the crime rate in neighbourhoods. The results of the spatial regressive model show that property crime rates are the highest where the proportion of single people ($b = 0.25$, $p<0.001$) is largest. Property crime rates are also the highest where the proportions of transfer payment recipients ($b = 0.23$, $p<0.001$) and dwellings constructed before 1961 are largest ($b = 0.14$, $p<0.05$). Thus, in Thunder Bay access to economic resources is associated with higher violent and property crime levels at the neighbourhood level.

Table 3.5

Regression models for crime rates,[1,2] Thunder Bay neighborhoods, 2001

	Violent crime rate[4]	Property crime rate[4]
Adjusted coefficients of determination (r^2)	0.46	...
Square correlation coefficients	...	0.45
Regression coefficients (b)		
Low-income households[3]	0.23**	...
Single, never married[3]	0.35***	0.25***
Part of government transfers in total income[3]	0.23**	0.23***
Dwellings built before 1961[3]	...	0.14*
Spatial lag	...	0.41***

... not applicable

* $p<0.05$.

** $p<0.01$.

*** $p<0.001$.

1. Crime rates per 1,000 residential and employed population.
2. Based on 207 dissemination areas.
3. Variables are standardized and normalized.
4. Regression models include intercept.

Sources: Statistics Canada, Canadian Centre for Justice Statistics, Incident-based Uniform Crime Reporting Survey, geocoded database, 2001, Census, 2001 and City of Thunder Bay Zoning Data.

Summary of findings – Thunder Bay

In Thunder Bay and Halifax, violent crimes and property crimes exhibit similar spatial distributions. In Thunder Bay, crime is essentially concentrated in the Fort William and Port Arthur downtowns. More specifically, crime gradually diminishes as one gets further from the city centres and approaches the suburbs. This concentric structure of crime has previously been observed in other places, including Winnipeg (Fitzgerald et al. 2004) and Regina (Wallace et al. 2006).

When all other factors are taken into consideration, variations in the violent crime rate model at the neighbourhood level are statistically related to the proportion of single people and people with limited economic resources, either where government transfers represent a larger proportion of total income or where a larger proportion of people live in low-income households. Variations in household crime are also statistically associated with the proportions of single people, people with government transfers and dwellings constructed before 1961.

Several variables associated with crime rates in the bivariate analysis do not account for a significant share of variations between the crime rates of DAs in the multivariate analysis. In particular, this is the case with the proportion of people with a university diploma, those who had moved in the past year, lone-parent families and Aboriginals. The strong association between concentrated disadvantage and crime has been demonstrated frequently in the research. For example, Sampson and Randenbush (1999) have argued that relationship between disadvantage and crime is, in fact, so strong that other 'symptoms' stem from the socio-economic disadvantages.

Endnotes

12. The definition of the term 'neighbourhood' used in this analysis corresponds to the term 'dissemination area' (DA). For more information, see the Methodology section.
13. The population at risk includes the population that lives and/or works within the boundaries of a particular DA. Rates are said to be local because they include only incidents and population at risk that are nearby, that is, within less than 500 metres. For more information, see the Methodology section.
14. The distance to the city centre is the distance between the geometric centre of each DA and the city centres of Fort William and Port Arthur. The lower of the two values was retained as the distance to the closest city centre. Fort William's city centre is located at the intersection of May and Arthur streets, whereas Port Arthur's city centre is located at the intersection of Red River and Cumberland streets.
15. Map of distribution of various crime incidents appears in Appendix 3: Neighbourhood characteristics and the distribution of crime in Thunder Bay.
16. Detailed breakdowns of zoning categories are included in the Methodology section.
17. For more information on the multivariate analysis, see the Methodology section.

Discussion

The research findings for Edmonton, Halifax and Thunder Bay show that crime is not distributed randomly in urban areas, but is instead concentrated in particular neighbourhoods, especially those in city centres. In Edmonton, Halifax and Thunder Bay, the spatial distribution of property crime is, despite some differences, strongly related to that of violent crimes.

Several differences between the characteristics of high-crime neighbourhoods and those of lower-crime neighbourhoods were noted. These differences can be grouped under three broad dimensions, demographic, socio-economic and functional.

Demographic dimension

In the cities studied, the demographic characteristics of high-crime neighbourhoods differ from those of lower-crime neighbourhoods. High-crime neighbourhoods have a higher density of the population at risk, and that population has specific characteristics. The population of high-crime neighbourhoods has a larger proportion of single people, people living alone, young males aged 15 to 24, Aboriginals, people who moved in the year preceding the census and lone-parent families.

The analyses presented here do not establish causal links between these residents and the crime level in their neighbourhood. However, many studies have found links between these demographic characteristics and higher rates of victimization and even of delinquency (Kong 2005). These characteristics also play a role in the ability of neighbourhood residents to exercise supervision and informal social control (Cohen and Felson 1979).

Socio-economic dimension

In the cities studied, crime appears to be higher in neighbourhoods whose residents have more limited access to socio-economic resources. High-crime neighbourhoods are characterized by a population that is more disadvantaged in economic terms (higher unemployment rate and proportion of low income and government transfers, and lower incomes), and they have a smaller proportion of highly educated people. A larger proportion of the population of high-crime neighbourhoods spend more than 30% of their income on shelter, and a smaller number of owners occupy their dwelling, regardless of whether these neighbourhoods are located near city centres or are on the periphery of the municipality. High-crime neighbourhoods are also characterized by older dwellings or dwellings in need of major repairs.

The overlapping of these different socio-economic characteristics in cities was abundantly shown by the poverty and social exclusion project of the Canadian Government's Policy Research Initiative (Horizon 2004). The Research Initiative's conclusions emphasized that the phenomenon of social exclusion and the persistence of low income are closely related (Lock, Kunz and Frank 2004). Many of the factors associated with the persistence of low income reflect the lack, ineffectiveness or disruption of social networks, more especially the social ties that provide access to income from stable paid employment (Hatfield 2004). People belonging to groups at risk (lone-parent families, elderly people living alone, people with a disability that limits their ability to work, Aboriginals living off reserve and new immigrants) share a number of problems, but each stands out by a specific event, whether it be a change in family status or even the lack of family status, a health problem or a move (Hatfield 2004).

In this context, then, high neighbourhood crime rates appear to reflect the absence, disruption or ineffectiveness of social networks that enable people to participate in the community and exert social control. Crime would appear to be a symptom of social exclusion, with social exclusion in turn blocking neighbourhood residents from exerting social control.

Functional dimension

The functional characteristics of neighbourhoods play a role in the variation in crime levels registered at the neighbourhood level. High-crime neighbourhoods are the busiest neighbourhoods, either because they are located near city centres or because they support intense levels of commercial activity.

While the city centres are the largest hot spots in Edmonton, Halifax and Thunder Bay in absolute numbers, some places have higher crime rates. Most of these hot spots are areas of intense commercial activity (shopping malls and megastores). These places are characterized by a relatively large number of property crimes (most of which are thefts under $5,000) but also, to a lesser extent, violent crimes. West Edmonton Mall is an especially obvious example of this type of hot spot.

As to residential neighbourhoods, they are moderate crime areas. Various types of crimes are recorded there, including breaking and entering and assault, but they do not exhibit any particular spatial concentration, except for a few very high-density housing developments.

Other hot spots are institutional: schools, universities, hospitals, etc. While these places have more of certain types of crimes (such as arson incidents in schools), the population at risk in these places is heavily underestimated in our analyses, and neither students nor patients are taken into account.

The overall picture

When all other study characteristics are taken into account, a limited number of factors are found to be linked to the variation in the crime rate at the neighbourhood level. The set of explanatory factors varies in a specific way according to the city studied and the type of crime, violent or property. The three major dimensions (demographic, socio-economic and land use) are included in the various explanatory models.

Whereas some variables do not contribute significantly to the multivariate regressive models, this does not invalidate the role that they may play in the organization of crime. Indeed, it is owing to the combined effect of a number of characteristics that some neighbourhoods are more at risk. Owing to the accumulation and overlapping of these characteristics, some neighbourhoods are especially at risk (Massey 1996, Forrest and Kearns 2001, Sampson et al. 2002).

The analyses conducted in this study bear out the notion that the spatial organization of crime must be understood as the result, at a given time, of a slow and complex process of urban development. Neighbourhoods evolve with their inhabitants. Buildings age and are renovated or fall into disrepair; residents move away or remain; and communities are displaced, rebuilt and transformed.

Neighbourhoods are configurations of physical and symbolic conditions that shape everyday experience and the identity of their inhabitants (Debarbieux 2003). These conditions, which are specifically local, can play a major role in the occurrence of crime. It is in this evolving and complex context, situated in a specific time and place, that crime, its spatial organization and its links to the neighbourhood, must be understood.

These results suggest that the development of crime reduction strategies could be based on the local specifics of the demographic, socio-economic and land-use dimensions. If crime reduction strategies are based on the specific needs of each city—i.e., its history and the means available at the neighbourhood and community level—they will be more likely to achieve their objectives.

This multitude of demographic, socio-economic and land-use characteristics also suggests that a range of stakeholders should be involved and partnerships formed among different local players[18] when developing and implementing crime prevention strategies. In fact, from the perspective of long-term change and the development of well-being in Canadian communities, crime prevention efforts should focus on creating an environment conducive to the broad and effective participation of partners in crime prevention, at all levels.

Limitations and opportunities

Studies based on the spatial analysis of crime should include a mass of information sources to adequately cover crime's different dynamics and aspects. The studies in this report were conducted using statistical data from police services, which include only crimes that are reported to them and confirmed by a police investigation. Many factors can influence police-reported crime rates, including the willingness of the public to report crimes to the police, and changes in legislation, policies or enforcement practices.

Thus, in the coming years it would be useful to examine, at the neighbourhood level, the information collected in victim and offender surveys, which in turn would provide a picture conducive to developing new crime prevention strategies. Surveys of the population would identify and better define the role of community involvement and social inclusion and exclusion in combating crime. Sampson et al. (2002) examined the theoretical and technical difficulties in measuring a number of neighbourhood characteristics relevant to crime issues. In particular, they mention the value of measuring social networks, norms and collective efficacy, institutional resources, community involvement and the spatial routine of the residents and users of neighbourhoods.

Understanding the factors related to change over the years can help policy makers develop crime prevention and reduction strategies, and evaluate existing programs. With the arrival of the 2006 Census data, it will be possible to obtain new demographic and socio-economic data at the neighbourhood level. These data will offer the opportunity to focus on the change over time and thus, for the first time, allows us to look at the factors associated with variations in crime at the neighbourhood level, and see how these evolve together, using Geographic Information System (GIS) technology.

The explanatory models and research results presented here do not take into account the activities of criminal gangs or the interactions between them. These activities and interactions, which for the most part are intrinsically territorial in nature, undoubtedly affect variations in crime levels at the neighbourhood level. Currently, the effect of these activities and interactions is, to some extent, taken into account by the use of spatial lag variables in autoregressive models, but no data enable us to determine what proportion of the spatial variables is attributable to them. The data needed to quantify interactions between criminal gangs are not available through the Uniform Crime Reporting (UCR) Survey. However, using the most recent version of the UCR Survey (2005), it will be possible to identify the presence of activities related to organized crime in neighbourhoods.

Also, despite the operational problems that this poses, incorporating existing social programs and crime reduction programs into subsequent analyses might make it possible to get a better understanding of the effectiveness of those programs with respect to crime prevention. It is important to pursue research on how to develop and evaluate strategies such as after-school programs and Neighbourhood Watch. This information would assist in answering questions such as the following: Do crime reduction programs actually reduce criminal activity? Does criminal activity merely shift to other neighbourhoods? What types of social or crime prevention programs are the most effective?

Endnote

18. Including partnerships among government departments, community groups, non-government organizations, the business community and citizens.

Methodology

Data sources

Incident-based Uniform Crime Reporting Survey

The Incident-Based Uniform Crime Reporting Survey (UCR2) collects detailed information on individual criminal incidents reported to the police, including characteristics of incidents, accused people and victims.

The UCR2 Survey allows a maximum of four offences per criminal incident to be recorded in the database. The selected offences are classified according to their level of seriousness, which is related to the maximum sentence that can be imposed under the *Criminal Code*.

Analyses of major offence categories (violent offences, property offences, drug-related offences and other *Criminal Code* offences) undertaken in this report are based on the most serious offence in each incident, as are the crime rates published annually by the Canadian Centre for Justice Statistics (CCJS). In this type of classification, a higher priority is given to violent offences than to non-violent offences. As a result, less serious offences may be under-represented when only the most serious offence is considered.

The majority of analyses in this report are based on major offence categories, such as violent offences and property offences, and take into account only the most serious offence in each incident. However, when the analysis is focused on individual offence types, all incidents in which the offence is reported are included, whatever the seriousness or the ranking of the offence in the incident. This method provides a more complete spatial representation of the different types of individual offences.

This report includes most *Criminal Code* offences and all offences under the *Controlled Drug and Substances Act*, but it excludes offences under other federal and provincial statutes and municipal by-laws. Also excluded are *Criminal Code* offences for which there is either no expected pattern of spatial distribution or a lack of information about the actual location of the offence. For example, administrative offences including bail violations, failure to appear and breaches of probation are typically reported at court locations; threatening or harassing phone calls are often reported at the receiving end of the call; and impaired driving offences may be more likely to be related to the location of apprehension (for example, apprehensions resulting from roadside stop programs).

Census of population

The Census of Population provides the population and dwelling counts not only for Canada but also for each province and territory, and for smaller geographic units, such as cities or districts within cities. The census also provides information about Canada's demographic, social and economic characteristics.

The detailed socio-economic data used in this report are derived from the long form of the census, which is completed by a 20% sample of households. These data exclude the institutional population, that is, people living in hospitals, nursing homes, prisons and other institutions.

The Census of Population is conducted by Statistics Canada every five years, most recently in 2006. To achieve the highest degree of compatibility between neighbourhood characteristics derived from the census and crime information, this report draws on police data from 2001 and census data from the same year. When the Edmonton, Halifax and Thunder Bay studies were conducted, detailed data from the 2006 Census on population characteristics, in particular on individuals' income, were not yet available at the neighbourhood level.

Land use data

Land use data were used to calculate the proportions of neighbourhoods with commercial, multi-family residential and single-family residential zoning. Land use data show the actual use of urban lands, whereas zoning data reflect planned and legislated use. Land use parcels were aggregated to the neighbourhood level to calculate proportions.

- Edmonton

  Zoning data for the City of Edmonton include several categories that do not correspond to the categories used in other cities. For example, the West Edmonton Mall is classified under "site specific development control provision," a category that is not found in the other cities studied and cannot be matched with any of their categories. To deal with this situation, the variable "retail trade worker" from the 2001 Census was used as an indicator of commercial land use.

- Halifax

  Zoning data come from the services and geographical information systems of the Halifax Regional Municipality.

- Thunder Bay

  The zoning data come from the Planning Division of the City of Thunder Bay.

Geocoding

Geocoding is the process of matching a particular address with a geographic location on the earth's surface. In this report, the address corresponds to the location of an incident that was reported to the police, after aggregation to the block-face level—that is, to one side of a city block between two consecutive intersections. This is done by matching records in two databases, one containing a list of addresses, the other containing information about the street network and the address range within a given block. The geocoding tool will match the address with its unique position in the street network. As the street network is geo-referenced (located in geographic

space with reference to a co-ordinate system), it is possible to generate longitude and latitude values—or X and Y values—for each criminal incident. Where the incident location does not correspond to an address, geocoding is performed by creating a point on, say, an intersection of two streets, a subway station or the middle of a public park. X and Y values in the criminal incident database provide the spatial component that allows points to be mapped, relative to the street or neighbourhood in which they occurred.

In 2001, the UCR2 Survey did not lend itself to collecting information on the geographic location of criminal incidents. For the purposes of this report, the Edmonton, Halifax and Thunder Bay police services sent the CCJS the addresses of the incidents selected, reported and entered in the UCR2 database in 2001 and 2003. This information was resolved by the CCJS into a set of geographical co-ordinates (X and Y) for each address. These co-ordinates were rolled up to the mid-point of a block-face in the case of specific addresses, and to intersection points in the case of streets, parks and subway stations. All addresses of criminal incidents that were reported more than five times but failed the automated geocoding process were geocoded manually so as to represent crime concentrations as accurately as possible. The low percentage of incidents that failed geocoding did not create a bias in offence trends. Incidents that failed geocoding contained information that was too vague, such as a bus number or the trans-Canada registration. In fact, geocoded offences and offences prior to geocoding both account for the same proportion of overall crime.

The Edmonton Police Service sent more than 58,800 selected incidents for 2001 and more than 69,700 for 2003. Geocoding was successful in more than 93% of the 2001 data and more than 92% of the 2003 data.

For its part, the Halifax Police Service sent more than 22,600 selected incidents in 2001. Geocoding achieved a success rate of 92%.

The Thunder Bay Police Service sent nearly 7,000 selected incidents in 2001 and more than 7,300 in 2003, of which respectively 98% and 93% were geocoded.

Mapping techniques

In this report, the method of representing crime and the other aspects analysed consists of a constellation of points, where each point corresponds to a criminal incident or a residential address of an accused. This method shows high-density crime locations or 'hot spots.'

Mapping hot spots: Kernel analysis

Kernel analysis is an alternative method of making sense of the spatial distribution of crime data. This method makes it possible to examine criminal incident point data across neighbourhood boundaries and to see natural distributions and the areas where these incidents are concentrated. The goal of kernel analysis is to estimate how the density of events varies across a study area based on a point pattern. Kernel estimation was originally developed to estimate probability density from a sample of observations (Bailey and Gatrell 1995). In its application to spatial data, kernel analysis produces a smooth map of density values, where the density of each place corresponds to the concentration of points in a given area.

In kernel estimation, a fine grid is overlaid on the study area. Distances are measured from the centre of a grid cell to each observation that falls within a predefined region of influence known as a bandwidth. Each observation contributes to the density value of that grid cell based on its distance from the centre of the cell. Nearby observations are given more weight in the density calculation than those farther away. In this study, the grid cell size is 100 square metres in Edmonton and Halifax. The research radius used is 1,000 metres in Edmonton and Halifax, and the higher the research radius, the smoother the image produced. Because the City of Thunder Bay is smaller, the grid cell is set at 50 square metres and the research radius is 500 metres.

The product of the kernel estimation method is a simple dot matrix (raster image) displaying contours of varying density. Contour loops define the boundaries of hot spot areas. Hot spots may be irregular in shape, and they are not limited by neighbourhood or other boundaries. This method of analysis was applied using the Spatial Analyst software of the Environmental Systems Research Institute.

The dual kernel method is also used in this study to examine the distribution of two variables simultaneously. Use of the dual kernel serves to standardize the distribution of crime based on the population at risk (the sum of the number of persons who reside or work in a neighbourhood). The dual kernel is obtained by calculating the ratio of crime density values to population at risk density values. To avoid having the concentration of a small number of incidents represented as a crime hot spot, an adjustment is made for areas where the crime and population at risk densities are low, these areas having artificially high values.

Definition of neighbourhoods

Ecological studies such as those conducted in crime-mapping projects require a sufficiently large number of geographic units or neighbourhoods for the modelling of data to be effective and reliable. In previous studies, the geographic units used were locally determined natural neighbourhoods (Winnipeg and Regina studies) or census tracts (Montréal).

In the framework of analysis carried out in Edmonton and Halifax, the definition of 'neighbourhood' used corresponds to the census tract (CT). The terms 'census tracts' and 'neighbourhoods' are used interchangeably. The natural neighbourhoods used in this analysis correspond to CTs, which are delineated by Statistics Canada in conjunction with a committee of local experts (e.g., planners, social workers, health care workers and educators). The initial rules for delineation, in order of priority, are as follows:

1) The CT boundaries should follow permanent and easily recognizable physical features.
2) The population of the CT should be from 2,500 to 8,000 people, preferably averaging around 4,000.
3) CTs should be as homogeneous as possible with respect to socio-economic characteristics.

CTs are also used in many other studies, and this makes it possible to add layers of supplementary information (health, education, economic factors, etc.) for an integrated approach toward prevention in neighbourhoods with a number of risk factors.

For reasons of data confidentiality and reliability, Statistics Canada requires that when using individual, family or household income data, the population size for any Canadian geographic area being considered must be least 250 people living in at least 40 private households. As a result, in Edmonton, only 147 of the 160 CTs are included. A map is appended showing the coverage of the 147 CTs over the territory of the City of Edmonton. In Halifax, each of the 51 census tracts have sufficient population to be included in the study. A map is appended showing the coverage of the 51 CTs making up the city of Halifax.

In the analyses of Thunder Bay, the number of CTs (30) available for analysis with insufficient. The DAs of the 2001 Census were therefore retained. It is the smallest standardized spatial unit to which data were disseminated.

DAs are small areas consisting of one or more blocks, with boundaries delimited by intersecting streets generally enclosing 400 to 700 residents. DAs must meet various delineation criteria designed to maximize their usefulness, including the following: DA boundaries respect the boundaries of census sub-divisions and census tracts; DA boundaries follow roads as well as railways, water features and power transmission lines, where these features form part of the boundaries of census sub-divisions or CTs.

In the analyses of Thunder Bay, neighbourhoods' demographic and socio-economic characteristics are the characteristics of the population of DAs in the 2001 Census. The terms 'DA' and 'natural neighbourhood' are therefore interchangeable.

Only 207 of 209 Thunder Bay DAs are included in the analyses because of confidentiality and reliability rules, as explained previously. A map is appended showing the coverage of the 207 DAs.

Description of variables

Crime variables and population at risk

Usually crime rates are calculated by examining the distribution of incidents based on the residential population of a given area. This method produces good results at the urban, provincial and national levels, but presents challenges when spatial components of interest, like neighbourhoods, are small and have low residential populations.

The distribution of criminal incidents across urban areas is often concentrated in or near the city centre, where residential populations are relatively low, but where there are high concentrations of people working or engaging in other activities. Rates based on residential population alone will artificially inflate the crime rates in these urban core neighbourhoods, as the total population at risk in these areas has not been taken into account.

To more accurately gauge the risk of crime in neighbourhoods, crime rates are based on the population at risk. An approximation of the population at risk is obtained by adding the number of workers and the number of residents in each neighbourhood. Rates based on these combined populations more closely approximate the total number of people at risk of experiencing crime. This report uses the approach taken in the Winnipeg research project (Fitzgerald 2004). Table 1.1, Table 2.1 and Table 3.1 show rates based on the residential population and the population at risk in the areas.

- Violent offence rates per 1,000 residents and workers. Violent offences include homicide, attempted murder, sexual assault, assault, violations resulting in the deprivation of freedom, robbery, extortion, criminal harassment, uttering threats, explosives causing death or bodily harm, and other violent crimes.
- Property offence rates per 1,000 residents and workers. Property offences include arson, breaking and entering, theft $5,000 and under, theft over $5,000, vehicle theft, possession of stolen goods, fraud and mischief.

2001 Census of population variables

Population characteristic variables

- Males aged 15 to 24 as a percentage of the total neighbourhood population. This age group is at highest risk of offending. In Canada in 2001, people aged 15 to 24 represented 14% of the total population, but accounted for 46% of the people accused of property crimes and 31% of those accused of violent crime.
- Percentage of the neighbourhood population that is 65 years and older. Results from the General Social Survey (GSS) on victimization suggest that national rates of criminal victimization among the elderly are relatively low compared to the population as a whole, although elderly people report feeling less safe (Gannon and Mihorean 2005).
- Percentage of single people in the neighbourhood, defined as single people aged 15 and older who have never been married. According to the 2004 GSS, single people are more at risk of experiencing violence. This situation is partly due to the fact that single people tend to participate more often in evening activities and are generally younger, and both these factors are strongly linked to a higher risk of victimization. In 2004, people who participated in at least 30 evening activities every month also had the highest rates of violent victimization (174 per 1,000 population). This rate was 4 times higher than that noted for people participating in fewer than 10 evening activities per month (44 incidents per 1,000 population).
- Percentage of the neighbourhood population immigrating to Canada from 1991 to 2001. Initially, immigration may hinder integration into society; however, this drawback is lessened as the length of residence in the country increases (Breton 2003). Recent immigrants' social participation may be more limited, and consequently, they may not be able to benefit to the same extent from social capital or from relationships within the community. Numerous studies have demonstrated links between reduced levels of social participation and increased levels of crime (Morenoff, Sampson and Raudenbush 2001; Sampson, Raudenbush and Earls 1997; Sampson 1997).
- Percentage of visible minority residents in the neighbourhood. Members of visible minorities "are people, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour." In 2002, according to the Ethnic Diversity Survey, roughly 9% of Canadians who reported being victims of crime in the previous five years believed that the offence perpetrated against them could be considered a hate crime. Members of visible minorities were 1.5 times more likely than non-members of visible minorities to have been a victim of a hate crime (13 per 1,000 population and 20 per 1,000 population, respectively) (Silver, Mihorean and Taylor-Butts 2004).

- Percentage of people with an Aboriginal identity living in the neighbourhood. Includes people who reported identifying with at least one Aboriginal group, that is North American Indian, Métis or Inuit (Eskimo), who reported being a Treaty Indian or a Registered Indian as defined by the *Indian Act* of Canada, or who reported they were members of an Indian Band or First Nation. The Aboriginal population in Canada is over-represented with respect to victimization and offending (Statistics Canada 2001a). Thus, according to the most recent cycle of the GSS, Aboriginal people were three times more likely than non-Aboriginals to have been a victim of a violent incident (319 compared to 101 per 1,000 population), even when other factors such as age, sex and income were taken into account (Gannon and Mihorean 2005).
- Percentage of lone-parent families among economic families living in private households. Although the after-tax income of lone-parent families is increasing in Canada, these families continue to be among the lowest income earners (Statistics Canada 2001b), and they are concentrated in the more disadvantaged areas of the city. Additionally, an increase in labour force participation among female lone-parents from 65% in 1995 to 82% in 2001 may be linked to decreased guardianship or supervision in neighbourhoods, which has been associated with higher crime rates (Cohen and Felson 1979).
- Percentage of people who have moved. Includes people who, on Census Day, resided at an address other than the one where they were living one year earlier. According to the 2004 GSS, people who have occupied their residence for only a short time are more likely to have their household victimized (317 incidents per 1,000 households) than those who have lived there for 10 years (196). Residential mobility has been associated with higher crime rates through reduced guardianship or social involvement that is more typical of frequent movers. Studies of American cities also indicate that streets where neighbours know each other or feel responsible for their community have significantly lower rates of violent crime than those where social interaction is lower (Block 1979; Sampson 1993).

Dwelling characteristic variables

- Percentage of dwellings constructed before 1961. In combination with other variables related to signs of physical decay within urban neighbourhoods, the age of urban buildings may be associated with higher crime rates through a perception of increased physical disorder (Kelling and Coles 1998).
- Percentage of dwellings in need of major repairs. Refers to whether, in the judgement of the respondent, the dwelling requires any repairs (excluding desirable remodelling or additions). Major repairs refer to the repair of defective plumbing or electrical wiring, structural repairs to walls, floors or ceilings, etc. This variable may similarly be associated with higher crime rates through the perception of increased physical disorder in the neighbourhood (Kelling and Coles 1998).
- Percentage of households spending more than 30% of total household income on shelter, including both owner-occupied and tenant-occupied households. This is a measure of housing affordability. The 30% Chart is based on research indicating that when the shelter costs of low-income households exceed 30% of their income, their consumption of other life necessities is reduced. Shelter expenses include payments for electricity,

oil, gas, coal, wood or other fuels, water and other municipal services, mortgage payments, property taxes, condominium fees and rent. Decreased housing affordability within a neighbourhood is another indicator of socio-economic disadvantage.

- Percentage of owner-occupied dwellings in the neighbourhood. Collective dwellings are excluded from both the numerator and denominator. Renters have the highest victimization rates among households. In 2004, the victimization rate for renters was 267 incidents per 1,000 households, compared to 242 for owners (Gannon and Mihorean 2005). Greater proportions of owner-occupied housing in a neighbourhood are linked to increased residential stability, social interaction among neighbours and a collective commitment to the neighbourhood. The 2003 GSS results show that people living in a neighbourhood for less than one year are less likely to know their neighbours (Schellenberg 2004).

Socio-economic variables

The results of research projects involving spatial analysis have shown major differences between the socio-economic characteristics of high-crime neighbourhoods and those of lower-crime neighbourhoods. High-crime neighbourhoods were characterized by reduced access to socio-economic resources (Fitzgerald, Wisener and Savoie 2004; Savoie, Bédard and Collins, 2006). A number of American studies have also demonstrated that inequality of socio-economic resources between neighbourhoods in American cities is strongly associated with the spatial distribution of crime (Morenoff, Sampson and Raudenbush 2001). In the present study, the following socio-economic variables are used:

- Percentage of total income consisting of government transfer payments, including employment insurance benefits; Old Age Security benefits, including the Guaranteed Income Supplement and the spouse's allowance; net federal supplements; Canada and Quebec pension plan benefits; the Canada Child Tax Benefit; New Brunswick, Quebec, Alberta and British Columbia family allowances; the goods and services tax credit; workers' compensation benefits; social assistance; and provincial or territorial refundable tax credits.
- Percentage of neighbourhood residents aged 20 and older without a high school diploma.
- Percentage of neighbourhood residents aged 20 and older who have obtained a bachelor's degree.
- Percentage of neighbourhood population in private households with low income in 2000. Low income refers to private households that spend 20% more of their disposable income than the average private household on food, shelter and clothing. Statistics Canada's low-income cut-offs (LICOs) are income thresholds that vary according to family and community size. Although LICOs are often referred to as poverty lines, they have no official status as such.
- Neighbourhood unemployment rate for population aged 15 and older participating in the labour force.
- Median household income in thousands of dollars or the dollar amount above and below which half the cases fall, namely the 50th percentile. Low household income increases the risk of violent victimization, while high income increases the risk of household victimization (Gannon and Mihorean 2005). It may be that potential thieves are more attracted to

higher-income households since their members probably own more property or property of greater perceived value.

City land use variables

- Commercial zoning—the proportion of square area within a neighbourhood zoned for commercial land use. Types of land use falling under commercial zoning include stores, supermarkets, discount stores, furniture stores, banks, hotels, motels, restaurants, service garages, service stations, full-service auto dealers, car washes, residential/commercial split properties and commercial offices.
  - o In Edmonton, commercial zoning is represented by the number of workers in the retail trade industry, sectors 44 and 45 of the 1997 North American Industry Classification System (NAICS).
  - o In Halifax, commercial zoning includes categories B, C-1, C-2, C-2A, C-2B, C-2C, C-2D, C-3, C-3A, C-4, C-6, CCDD, CGB, CHWY, CMC, CSC, CR-1, CR-2, DB, K, HZ, SC_MF1 and W, as defined by the City of Halifax.
  - o In Thunder Bay, commercial zoning includes categories CBD, RC1, RC2, SC, NC1, NC2, CG1, CG2, CSG, HC and SPC, as defined by the City of Thunder Bay.

- Multi-family residential zoning—the proportion of square area within a neighbourhood zoned for multi-family, two-family (duplex) or transitional dwellings, which include short- and longer-term subsidized housing for those in need.
  - o In Edmonton, multi-family residential zoning is represented by the percentage of dwellings in the census tract that are contained within an apartment building.
  - o In Halifax, multiple family residential zoning includes categories BSCDD, CDD, DN, K, R-2, R-2A, R-2AM, R-2P, R-2T, R-3, R-4, RMU, RTH, RTU, TH and WFCDD, as defined by the City of Halifax.
  - o In Thunder Bay, multi-family residential zoning includes categories R2, R2A, RM1, RM2A, RM2B and RM3, as defined by the City of Thunder Bay.

- Single family residential zoning—the proportion of square area within a neighbourhood zoned for single-family dwellings.
  - o In Edmonton, single family residential zoning is represented by the percentage of dwellings in the CT that are considered single detached houses.
  - o In Halifax, single family residential zoning includes categories BSCDD, BWCDD, CDD, H, HCR, K, MU-1, R-1, R-1M, R-2A, RA-1, RA-2, RA-3, RA-4, RB-1, RB-2, RB-3, RCDD, RDD, RR, RSU, T, V-1, V-3 et V-4, as defined by the City of Halifax.
  - o In Thunder Bay, single family residential zoning includes categories RE, RS, R1, R1A, RMH, RF1, RF2 and CR, as defined by the City of Thunder Bay.

- Institutional zoning—the proportion of the square area within a neighbourhood consisting of buildings or public spaces such parks, schools, hospitals and other government buildings.
  - In Halifax, institutional zoning includes categories AF, CFB, D-1, K, P, P-2, P-3, PK, POS, P_SI, RPK, RR, S, SI, TR, U-1, U-2 and W, as defined by the City of Halifax.
  - In Thunder Bay, institutional 1 zoning includes categories NIN, CIN and MIN, as defined by the City of Thunder Bay.

- Industrial zoning—the proportion of the square area within a neighbourhood consisting of industrial spaces.
  - In Halifax, industrial zoning includes categories C-5, CD-2, CD-3, F-1, I-1, I-2, I-3, I-4, IHI, IHO, ILI, M, P5, W and WFCDD, as defined by the City of Halifax.
  - In Thunder Bay, industrial zoning includes categories FI, SI, LI, LIP, HI, EI, HRI, RR, PBP and GBP, as defined by the City of Thunder Bay.

- Open space—the proportion of the square area within a neighbourhood consisting of spaces without any major buildings.
  - In Thunder Bay, open spaces include categories RU, OS, AIR, US, HL and FD, as defined by the City of Thunder Bay.

Multivariate analysis

Ordinary least squares (OLS) regression is used to examine the distribution of violent and property crime rates as a function of the set of explanatory factors. The use of this method requires a continuous or quantitative outcome variable that has a normal distribution. As a number of variables studied here do not have normal distributions, it was necessary to submit the crime variables to normalizing transformations. Most of the variables or neighbourhood characteristics were also changed so that they would exhibit a normal distribution. The combination of variables and the associated normalization techniques are included in the Methdology section.

The regressive models were developed using stepwise procedure. This method consists of a series of multiple regressions such that at each stage, the variable that accounts for the maximum remaining variance is added. At each stage, any superfluous variables are eliminated.

The standardized regression coefficients provide a means of assessing the relative importance of the different predictor variables in the multiple regression models. The coefficients indicate the expected change, in standard deviation units, of the dependent variable per one standard deviation unit increase in the independent variable, after controlling for the other variables. The maximum possible values are +1 and -1, with coefficient values closer to 0 indicating a weaker contribution to the explanation of the dependent variable.

Many neighbourhood characteristics in this study are closely correlated with each other; they convey essentially the same information (the correlation matrix is located in the appendix). This situation takes into account the close links between many structural factors that are individually linked to crime (Land, McCall and Cohen 1990). To take account of this multicolinearity, which is likely to distort the results of the models, variance inflation factors (VIFs) are used to measure the

multicolinearity between all independent variables in the regression models. A VIF greater than 10 indicates possible multicolinearity problems in a regression model (Montgomery, Peck and Vining 2001). Variables that register a VIF of 10 or more are, therefore, eliminated from the final models. Finally, because members of visible minorities and new immigrants account for only 2% of the population, these variables were not included in the multivariate models.

Another aspect that must be taken into account in spatial analysis of data, such as crime data, is spatial autocorrelation (see Spatial autocorrelation text box). The presence of spatial autocorrelation is detected in the residuals of the OLS regression models for Edmonton, that is, a Moran's *I* statistic of 0.12 ($p<0.005$) in the case of violent crimes and 0.19 ($p<0.001$) in the case of property crimes. Therefore, in modelling relationships between neighbourhoods, it is appropriate to take their relative geographic position into account. Thus, the use of a spatial autoregressive model is required.

Text box 1

Spatial autocorrelation

By Kristin Collins

Data measured over a two-dimensional study area, such as the geocoding of criminal incidents, are often affected by the properties of the location in which they reside. If adjacent observations are affected by the same location properties, the observations will not be independent of one another. This lack of independence must be accounted for in the data analysis to produce accurate and unbiased results. This is accomplished through spatial modelling of data and is important for any dataset where there is a potential effect of location.

Crime is known not to be evenly distributed across cities and to be concentrated in particular areas known as hot spots. This indication of a location effect can be seen by examining a map of crime density in city neighbourhoods. A positive effect may occur in areas with high crime rates that are surrounded by other areas with high crime rates and areas with low crime rates that are adjacent to other areas with low crime rates. A negative location effect results from areas of low crime being surrounded by areas with high crime and vice versa. Either scenario indicates some sort of spatial structure or spatial dependence in the data, signifying that the neighbourhoods have an influence on each other. If the spatial structure of the data is not explained by the variables in the regression model, then there will be spatial effects in the model error terms. This phenomenon, which is known as spatial autocorrelation, violates the assumptions made in a standard regression analysis. The location effects must instead be accounted for in the multivariate models, to ensure accurate estimation of the regression coefficients and their associated variances.

For the purpose of spatial modelling, a definition of what constitutes neighbouring locations needs to be specified. In this analysis, a contiguity structure that includes all common borders or vertices that touch between the boundaries of the regions is used to define regions as neighbours of each other. The neighbourhood structure defines which locations have a potential influence on each other, the neighbours, and rules out any potential influence of regions that are not considered to be neighbours. The neighbourhood structure is used to test for spatial autocorrelation and to specify the spatial component in the autoregressive spatial model.

The basic process of modelling spatial data is to first fit a standard least squares regression model to the data and then test the error terms for the presence of spatial autocorrelation. This is done by a statistical test called Moran's I, which tests whether the error terms are randomly distributed over the study area. The value of the Moran's I statistic ranges from -1 to +1. A value approaching 1 indicates the presence of positive spatial autocorrelation, where regions with large error terms are adjacent to other areas with large error terms. A negative value near -1 indicates the presence of negative spatial autocorrelation, where regions with large error terms are neighbouring regions with small error terms. A value near zero indicates the absence of spatial autocorrelation. The significance of Moran's I statistic is determined by a random permutation approach, where a significant result indicates that there is spatial autocorrelation in the model error terms.

When spatial autocorrelation is detected in the residuals from a standard least squares regression model, a spatial model must be fit to the data instead. The spatial model provides the same analysis of the neighbourhood characteristics as the least squares model but adjusts for the spatial effects. This can be done in one of two ways: by adding an extra term to represent the effect of neighbouring locations or by modelling a spatial process in the error terms. In the former model, called the spatial lag model, a direct effect of the crime rate in neighbouring locations is assumed, in this case the average value from all neighbouring locations, termed the spatial lag, is added to the regression model to represent the direct effect of the neighbouring regions. The other model, termed the spatial error model, assumes the relationship between crime rates in adjacent neighbourhoods is the result of the same relationship of the explanatory variables in the adjacent neighbourhoods. Thus the spatial autocorrelation detected in the standard regression model is the result of spatially autocorrelated variables not present in the model. To determine the appropriate type of spatial model to use for any given dataset, the data are empirically tested to determine the structure of the spatial dependency.

The results from a spatial regression analysis are essentially the same as other multivariate regression analyses. The regression coefficients represent the change in the crime rate for a unit change in the variable, when all other variables are held constant. Since the variables representing the neighbourhood characteristics are standardised, the size of their regression coefficients denote their relative contribution to the prediction of crime. The spatial lag and spatial error regression coefficients, however, cannot be explained in the same way. The spatial lag coefficient in part represents the effect of neighbouring locations but also accounts for some of the measurement error in using administrative units to define the neighborhoods. Thus there is no direct interpretation of the spatial lag coefficient. Similarly, the spatial error coefficient represents a nuisance parameter in the model and has no direct interpretation. Rather, the spatial term is only retained in the model to make the other results accurate.

The overall fit of the spatial models is assessed by the squared correlation between the observed crime rate in each neighbourhood and the values predicted using the spatial model. This squared correlation is equivalent to the coefficient of determination (R^2) commonly used in standard regression models, where it represents the proportion of the variation explained by the regression model. However, in the presence of spatial autocorrelation the squared correlation between the observed and fitted values does not have the same interpretation. Rather, it represents the relative fit of the model. A value of 1 would represent a perfect fit of the model and values near zero indicate a poor predictive power of the model.

To ensure the spatial autocorrelation has been adequately accounted for in the models, the residuals from the spatial models are tested for the presence of spatial autocorrelation. This is done using Lagrange Multiplier tests, which test for the presence of spatial error dependence in the spatial lag model and for a missing spatial lag variable in the spatial error model. If the statistics are not significant, it indicates the spatial dependency in the data has been accounted for in the model.

Normalization techniques

Edmonton

No transformation	Natural logarithm	Square root
Population aged 15 and under	Violent crime rate	Property crime rate
Population at risk density	Ratio of male to female	Dwellings in need of major repairs
Lone-parent families	Population aged 65 and over	Unemployment rate
Owner-occupied households	Aboriginals	Recent immigrants(since 1991)
Without high school diploma (20 years and over)	Recent movers (1 year)	Visible minority population
	With university diploma (20 years and over)	Households spending 30% or more of income on housing
	Median employment income	Part of government transfers in total income
	Average value of dwelling	
	Median household income	Persons in low-income households
	Persons living alone	
	Dwellings built before 1961	
	Dwellings built after 1990	
	Single persons, never married	
	Young men (18 to 24)	
	Workers in retail trade	
	Multiple-family zoning	
	Single-family zoning	

Halifax

No transformation	Natural logarithm	Square root
	All variables included in the study	

Thunder Bay

No transformation	Natural logarithm	Square root
Open space zoning	Property crime rate	Violent crime rate
Single-family zoning	Single persons, never married	Population aged 65 and over
Multiple-family zoning	Unemployment rate	Persons living alone
Industrial zoning		Recent movers (1 year)
Institutional zoning		Aboriginal
Commercial zoning		Without high school diploma (20 years and over)
Ratio of male to female		
Population aged 15 and under		With university diploma (20 years and over)
Lone-parent families		
Owner-occupied households		Median employment income
Dwellings in need of major repairs		Part of government transfers in total income
Dwellings built before 1961		
Dwellings built after 1990		Persons in low-income households
Professional occupation		Households spending 30% or more of income on housing

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Crime and Justice research paper series

Cumulative Index

The **Canadian Centre for Justice Statistics** (CCJS) was created in 1981 as a division of Statistics Canada. The CCJS is the focal point of a federal-provincial-territorial partnership for the collection of information on the nature and extent of crime and the administration of civil and criminal justice in Canada. This partnership, known as the "National Justice Statistics Initiative", has become the international model of success on how to develop, implement and manage an effective national justice statistics program. Its analytical output appears in the flagship publication *Juristat* (http://www.statcan.ca/english/IPS/Data/85-002-XIE.htm), in various annual and biennial publications, and in the *Crime and Justice research paper series* (http://www.statcan.ca/english/IPS/Data/85-561-MIE.htm).

Following is a cumulative index of Canadian Centre for Justice Statistics research papers published to date:

Crime and Justice Research Paper Series – Research papers

85-561-MIE2003001	An examination of sex differences in delinquency
85-561-MIE2003002	Childhood aggression and exposure to violence in the home
85-561-MIE2003003	Prior police contacts and police discretion with apprehended youth
85-561-MIE2004004	Neighbourhood characteristics and the distribution of crime in Winnipeg
85-561-MIE2005005	Exploring crime patterns in Canada
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85-561-MIE2006007	Neighbourhood characteristics and the distribution of crime on the Island of Montréal
85-561-MIE2006008	Neighbourhood characteristics and the distribution of crime in Regina
85-561-MIE2007009	The Development of Police-reported Delinquency Among Canadian Youth Born in 1987 and 1990
85-561-MIE2008010	Neighbourhood Characteristics and the Distribution of Crime: Edmonton, Halifax and Thunder Bay